CHAPTER 5

NAVY AIRCREW COMMON EJECTION SEAT (NACES)

Chapter Objective: *Upon completion of this chapter, you will have a working knowledge of the Navy Aircrew Common Ejection Seat (NACES), including functional description, physical description, component identification, and maintenance concepts.*

The incorporation of the Navy Aircrew Common Ejection Seat (NACES) in Navy aircraft represents a significant improvement in ejection-seat design that takes advantage of the latest escape system technology. The NACES system gives the aircrew improved chances for escape in all ejection situations, reduced potential for injury, extended preventive maintenance intervals, and a significant reduction in life-cycle costs. This Martin-Baker ejection seat will be fitted to the new Grumman F-14D *Tomcat,* the McDonnel Douglas/British Aerospace T-45A *Goshawk* two-seat trainer, and the McDonnel Douglas F/A-18C and D aircraft.

The purpose of the common ejection seat is to ease the logistics and maintenance problems on the Navy's inventory of aircraft. The new seat will increase the standardization and reliability of aircraft emergency escape and aircrew and ground crew training. The electronically controlled NACES represents the state-of-the-art in escape system technology, and it has been selected as the future standard of the U.S. Navy. The NACES series was engineered from the outset for future growth potential. The ejection seat is designed for simple reprogramming or modification to ensure that it maintains current technology.

As a senior AME, you already have the prerequisite knowledge and experience to understand ejection seat theory. New ideas have been incorporated into the NACES. Now all that is required is your willingness to learn these new ideas so that NACES characteristics become as familiar as previous Martin-Baker ejection seats.

SYSTEM DESCRIPTION AND COMPONENTS

Learning Objective: *Recognize the functional and physical description of the NACES and the components within the system.*

The NACES system uses a flexible configuration to meet the exact requirements of the crew station designer. Although this is a common ejection seat, the designator number for the seat versus aircraft types are different, as shown below.

SEAT	TYPE AIRCRAFT-LOCATION
1. SJU-17(V)1/A	F/A-18C, F/A-18D, rear cockpit
2. SJU-17(V)2/A	F/A-18D, front cockpit
3. SJU-17(V)3/A	F-14D, rear cockpit
4. SJU-17(V)4/A	F-14D, front cockpit
5. SJU-17(V)5/A	T-45, rear cockpit
6. SJU-17(V)6/A	T-45, front cockpit

Although the physical description may differ between the seats used in the F-14D as compared to the F/A-18 and T-45 (fig. 5-1), the functions of all the seats are the same. In this chapter we will use the F/A-18 ejection seat to discuss system description, operation, function, and component identification.

FUNCTIONAL DESCRIPTION

WARNING

The emergency escape system incorporates several explosive cartridges and rockets containing propellant charges. Inadvertent firing of any of these may result in serious or fatal injury to personnel on, or in the vicinity of, the aircraft.

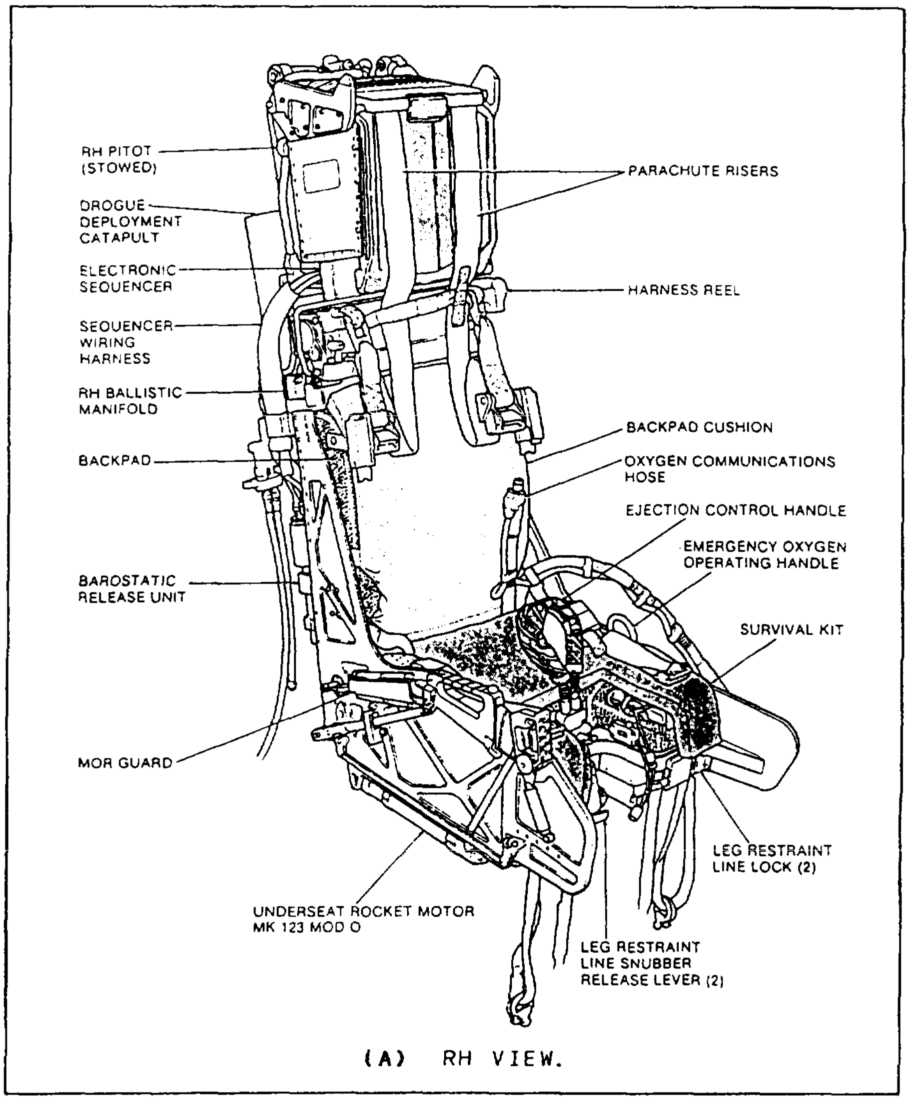


Figure 5-1.-Forward ejection seat; (A) right-hand view, (B) left-hand view.

Ejection control handle safety pins and safe/armed handles are provided to render the ejection seats safe when the aircraft is parked between flights and at all other times on the ground. The ejection control handle safety pins are removed by the aircrew before flight and installed by the plane captain after flight. Movement of the safe/armed handle is the responsibility of the aircrew.

Before entering the cockpit, personnel should ensure that the correct safety precautions have been applied.

The F/A-18 aircraft is equipped with a type SJU-17(V)1/A ejection seat. The F/A-18D aircraft is equipped with a type SJU-17(V)2/A and a type SJU-17(V)1 /A ejection seat installed in the forward and aft cockpits, respectively. The seats are interconnected by a command sequencing system. The two types of seat are essentially the same, but with differences to suit the two cockpit installations. For convenience, the description that follows applies equally to both ejection seats, except where noted. Where reference is made to the aft seat configuration on the F/A-18D, the description applies equally to the single seat (F/A-18C) installation.

All NACES seats incorporate fully automatic electronic sequencing and are cartridge operated and rocket assisted. Safe escape is provided for most combinations of aircraft altitude, speed, attitude, and flight path within the envelope of

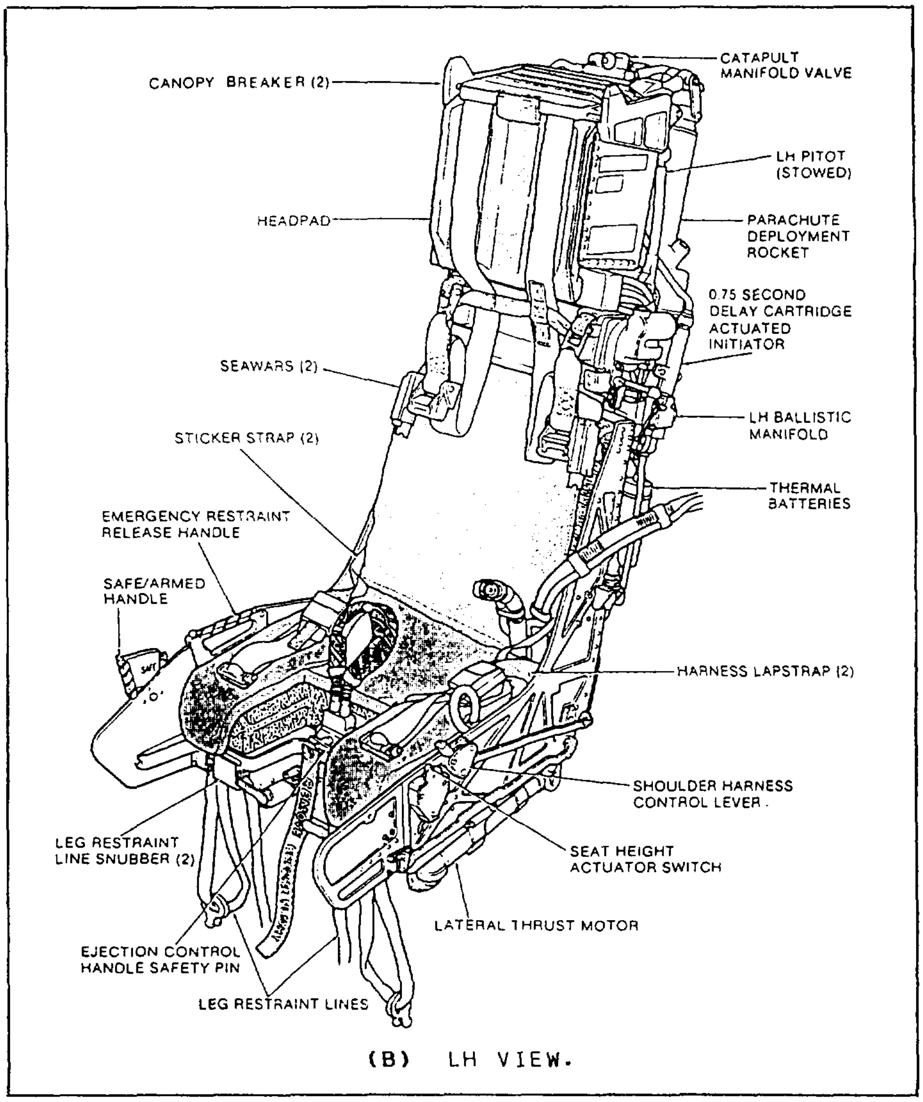


Figure 5-1.-Forward ejection seat; (A) right-hand view, (B) left-hand view—Continued.

zero speed, zero altitude in a substantially level attitude to a maximum speed of 600 knots estimated air speed (KEAS) between zero altitude and 50,000 feet.

Ejection is initiated by pulling a seat firing handle situated on the front of the seat bucket between the occupant's thighs. The parachute container is fitted with canopy breakers to enable the seat to eject through the canopy should the jettison system fail. After ejection, drogue deployment, man/seat separation, and parachute deployment are automatically controlled by an onboard multimode electronic sequencer. A barostatic harness release unit caters for partial or total failure of the electronic sequencer, and an emergency restraint release (manual override) system provides a further backup in the event of failure of the barostatic release.

The seat is ejected by action of the gas pressure developed within a telescopic catapult when the cartridges are ignited. An underseat rocket motor situated under the seat bucket is fired as the catapult reaches the end of its stroke, and sustains the thrust of the catapult to carry the seat to a height sufficient to enable the parachute to deploy even though ejection is initiated at zero speed, zero altitude in a substantially level attitude. The seat is stabilized and the forward speed retarded by a drogue and bridle system, followed by automatic deployment of the personnel parachute and separation of the occupant from the seat. Timing of all events after rocket motor initiation is controlled by the electronic sequencer, which uses altitude and airspeed information to select the correct mode of operation.

PHYSICAL DESCRIPTION

Each ejection seat, as installed in the aircraft, consists of five main assemblies. Each assembly is briefly described in the following paragraphs: (See figure 5-2.)

1. The catapult assembly is the means by which the ejection seat is secured to the aircraft structure during normal flight, and provides the initial force necessary to eject the seat from the aircraft during emergency conditions. The catapult assembly includes the barrel, ballistic latches, the piston, and the catapult manifold valve.

2. The main beams assembly includes the top and bottom crossbeams, top latch assembly, shoulder harness control handle, parachute deployment rocket motor, electronic sequencer, barostatic release unit, drogue deployment catapult, two multipurpose initiators, time-delay mechanism, two pitot assemblies, two ballistic manifolds, and two thermal batteries.

3. The seat bucket assembly includes the underseat rocket motor, lateral thrust motor, ejection control handle, safe/armed handle, leg restraint snubbers, emergency restraint release handle, shoulder harness control lever, seat height actuator switch, pin puller, and lower harness release mechanism.

4. The parachute assembly includes the parachute container and parachute canopy and drogue.

5. The seat survival kit assembly includes the lid assembly, emergency oxygen system, radio locator beacon, and rucksack assembly.

Catapult Assembly

The catapult assembly (figs. 5-3 and 5-4) secures the ejection seat to the aircraft structure

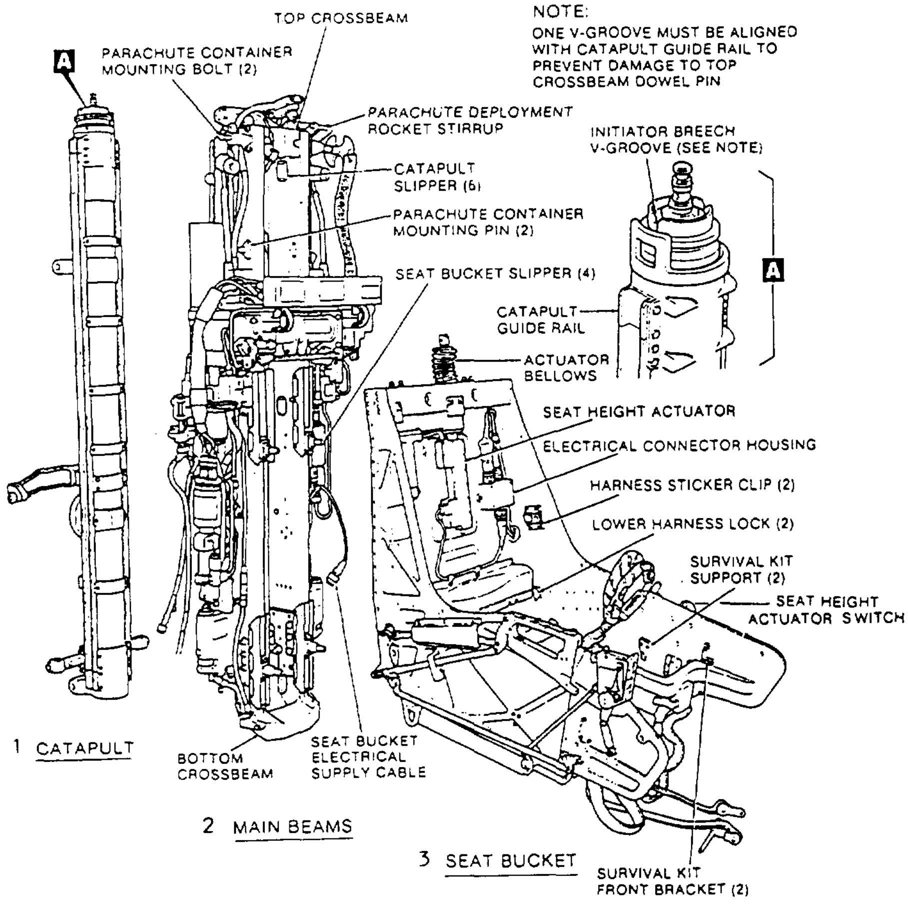


Figure 5-2.-Forward ejection seat main assemblies.

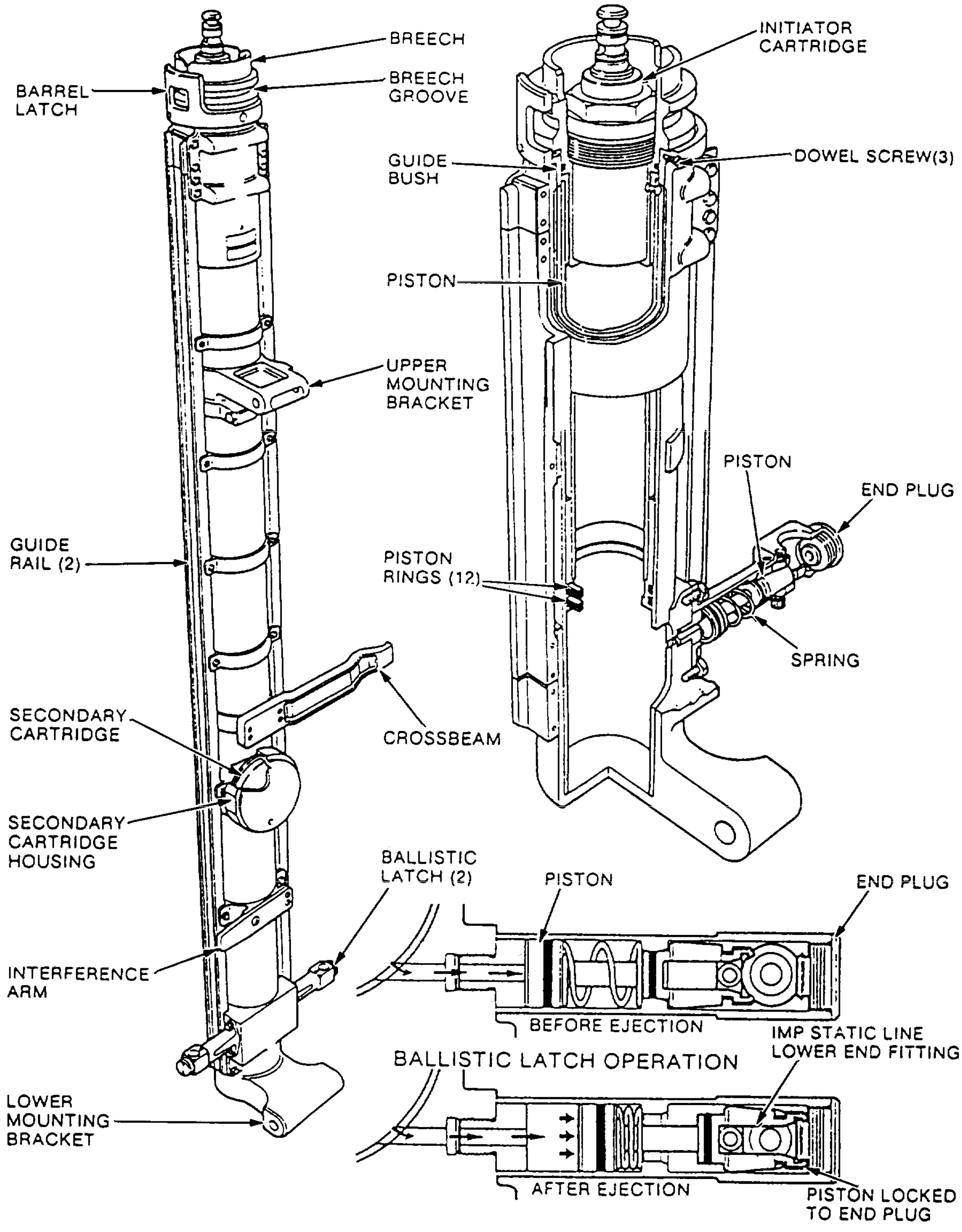


Figure 5-3.-Catapult assembly, forward seat.

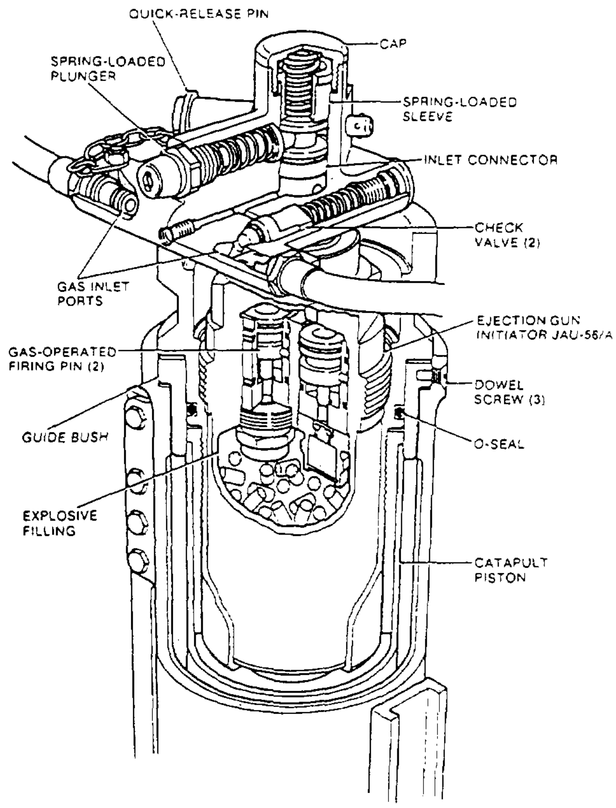


Figure 5-4.-Ejection gun initiator (JAU-56/A) and catapult manifold valve.

and provides the initial power for the ejection of the seat. The catapult consists of an outer barrel and an inner telescopic piston. The barrel is attached to the aircraft structure, and the piston and barrel are engaged at the top end by the top latch plunger installed in the main beams assembly.

The catapult assembly is operated by explosive charges. Assembly operation is discussed later in this chapter.

BARREL.— The barrel is a built-up structure consisting of a light alloy tube to which are permanently attached top and bottom end fittings. A housing situated towards the bottom end contains the secondary cartridge. Five brackets support two guide rails bolted on the outboard sides of the tube. The bottom end fitting incorporates the lower mounting bracket for attaching the catapult to the aircraft and studs for attachment of the ballistic latches.

The upper mounting consists of a bracket clamped on the barrel towards the upper end. It incorporates an interference shoulder on one side to ensure location of the catapult in the correct cockpit (fig. 5-5). An interference arm mounted on one of the guide rail brackets ensures that the correct main beams assembly is installed. A crossbeam secured to the barrel provides an anchorage point for the RH ballistic manifold quick-disconnect lanyard. The top end fitting of the barrel has a square aperture, the barrel latch, through which the plunger of the top latch mechanism fitted on the seat main beam protrudes when the seat is installed on the catapult. A guide bushing, fitted in the internal diameter of the top end fitting, is secured by three dowel screws; at the end of the catapult stroke, the dowel screws are sheared by the head of the piston striking the guide bushing. The piston then separates from the barrel, and the guide bushing remains on the piston (fig. 5-3).

BALLISTIC LATCHES.— Two ballistic latches are attached to the bottom end fitting by studs and nuts. Each latch comprises a body, which is internally drilled to form a cylinder and contains a spring-loaded piston. When operated during the ejection sequence, gas pressure from within the catapult acts on the latch pistons,

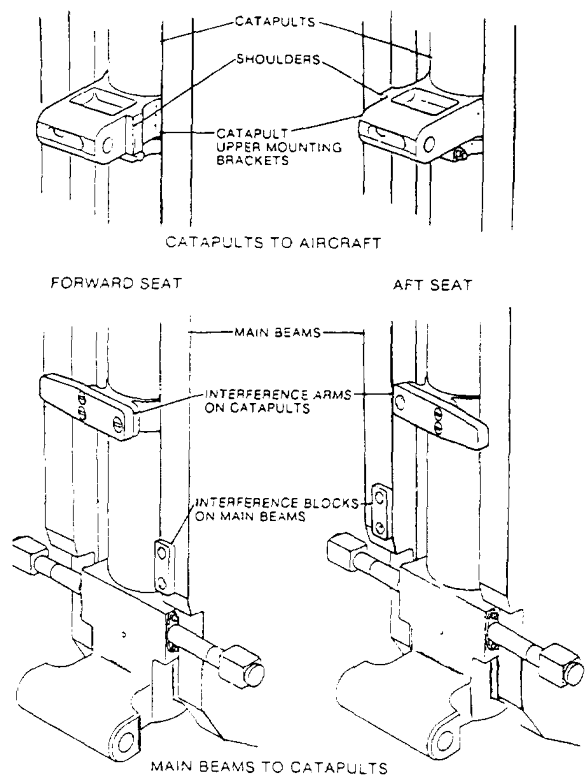


Figure 5-5.-Interference devices, forward and aft seats.

overcoming the springs and retaining the multi-purpose initiator lanyard spigots (fig. 5-3).

PISTON.— The piston consists of a light alloy tube, attached to the lower end of which is a necked end fitted with piston rings to provide a gas seal between the piston and the barrel. At the upper end of the piston is a breech, into which the cartridge-activated initiator is inserted. The breech has a groove machined around its outer diameter, into which the plunger of the top latch mechanism on the seat main beams engages when the seat is installed on the catapult. A V-groove in the top of the breech engages a dowel on the seat top crossbeam when the seat is installed in the aircraft (fig. 5-3).

CATAPULT MANIFOLD VALVE.— The catapult manifold valve provides an interface between the ejection seat and the catapult. The catapult manifold valve is mounted on the top of the catapult. The valve is locked onto the cartridge-activated initiator by a spring-loaded plunger and a retaining pin. The valve contains two inlet ports that connect the hoses from the time delays.

Main Beams Assembly

The main beams assembly is manufactured almost entirely from light alloy and comprises two parallel main beams bridged by top and bottom crossbeams. Bolted to the inside face of each main beam are three slippers, which engage in the guide rails on the catapult. Two-seat bucket runner guides are attached to the front face of each main beam and accommodate the top and bottom seat bucket slippers. The slippers provide smooth movement of the seat bucket and incorporate threaded studs for attachment of the seat bucket to the main beams. Friction pads are incorporated in the studs to damp out lateral movement of the seat bucket. Drogue bridle retaining channels are secured to the rear of both main beams. Locating pins for the parachute container hooked brackets are bolted to the upper outside face of each main beam. Interference blocks on the right-hand (RH) beam (forward seat) or left-hand (LH) beam (aft seat) correspond with interference devices on the catapult and the seat bucket to ensure that only the correct assemblies are installed in forward and aft cockpits.

TOP CROSSBEAM.— The top crossbeam accepts and locates the top of the catapult, and takes the full thrust of the catapult during ejection. Incorporated into the crossbeam is the upper drogue bridle release unit. A dowel in the top crossbeam locates in one of the catapult breech V-grooves when the seat is installed in the aircraft.

BOTTOM CROSSBEAM.— The bottom crossbeam retains and separates the main beams at the bottom end. Incorporated into the crossbeam is a gas passage that forms part of the drogue bridle release system.

TOP LATCH ASSEMBLY.— The seat structure is secured to the catapult by the top latch assembly (fig. 5-6) fitted to the LH main beam. The assembly consists of a housing that contains a spring-loaded latch plunger, one end of which is shaped to engage the catapult piston. The plunger may be withdrawn by using the top latch withdrawal tool (handwheel). Passing through the center of the latch plunger is a spring-loaded indicator plunger. When the ejection seat is fitted

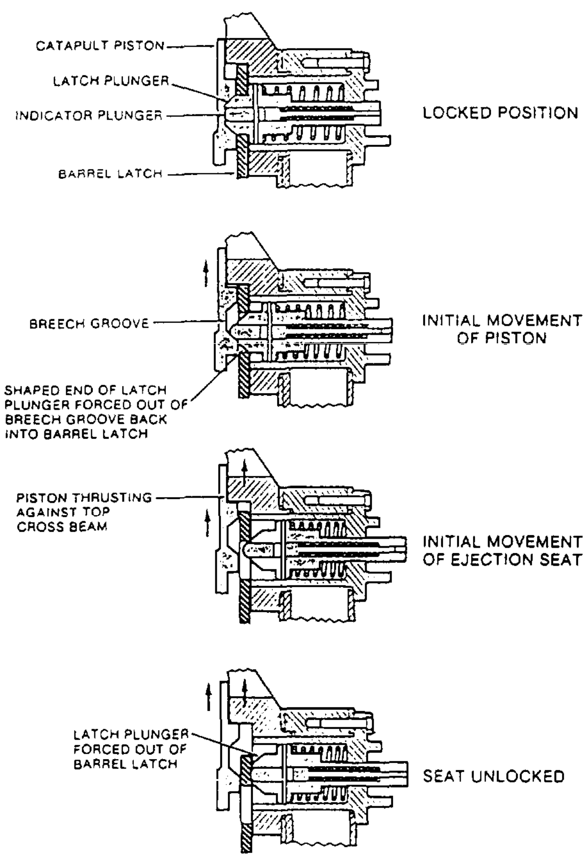


Figure 5-6.-Operation of top latch assembly.

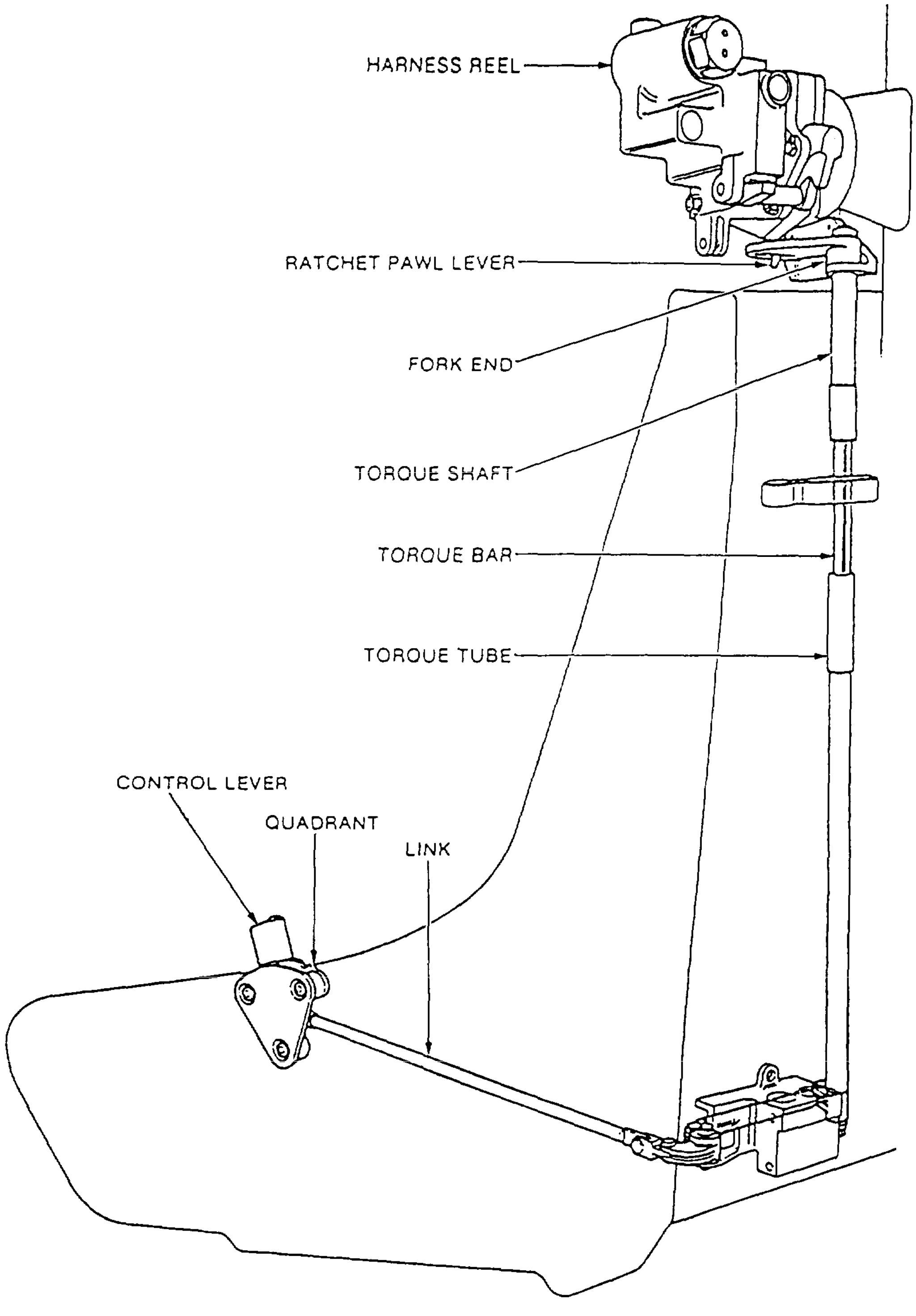


Figure 5-7.-Shoulder harness control system.

to the catapult and the handwheel removed, the latch plunger passes through the top crossbeam and engages with the barrel latch. The shaped end of the plunger protrudes still further to engage the groove of the catapult piston.

SHOULDER HARNESS CONTROL HANDLE.— The shoulder harness control handle (fig. 5-7) is located on the left side of the seat bucket. The handle is connected to the inertia reel. In the aft position, the reel is allowed to rotate freely. When the forward position is selected, straps will ratchet in, allowing no forward movement.

SHOULDER HARNESS REEL.— The shoulder harness reel (fig. 5-8, view A) is fitted horizontally across the front faces of the main beams and serves as a center crossbeam for the main beams assembly, as well as a means of securing the upper harness. It ensures that the occupant will be brought to, and locked in, the correct posture for ejection. For normal flight operations, the shoulder harness is free to extend and retract as the occupant moves in the ejection seat. The shoulder harness control lever on the LH side of the seat bucket can be moved to the forward (locked) position, which will permit the

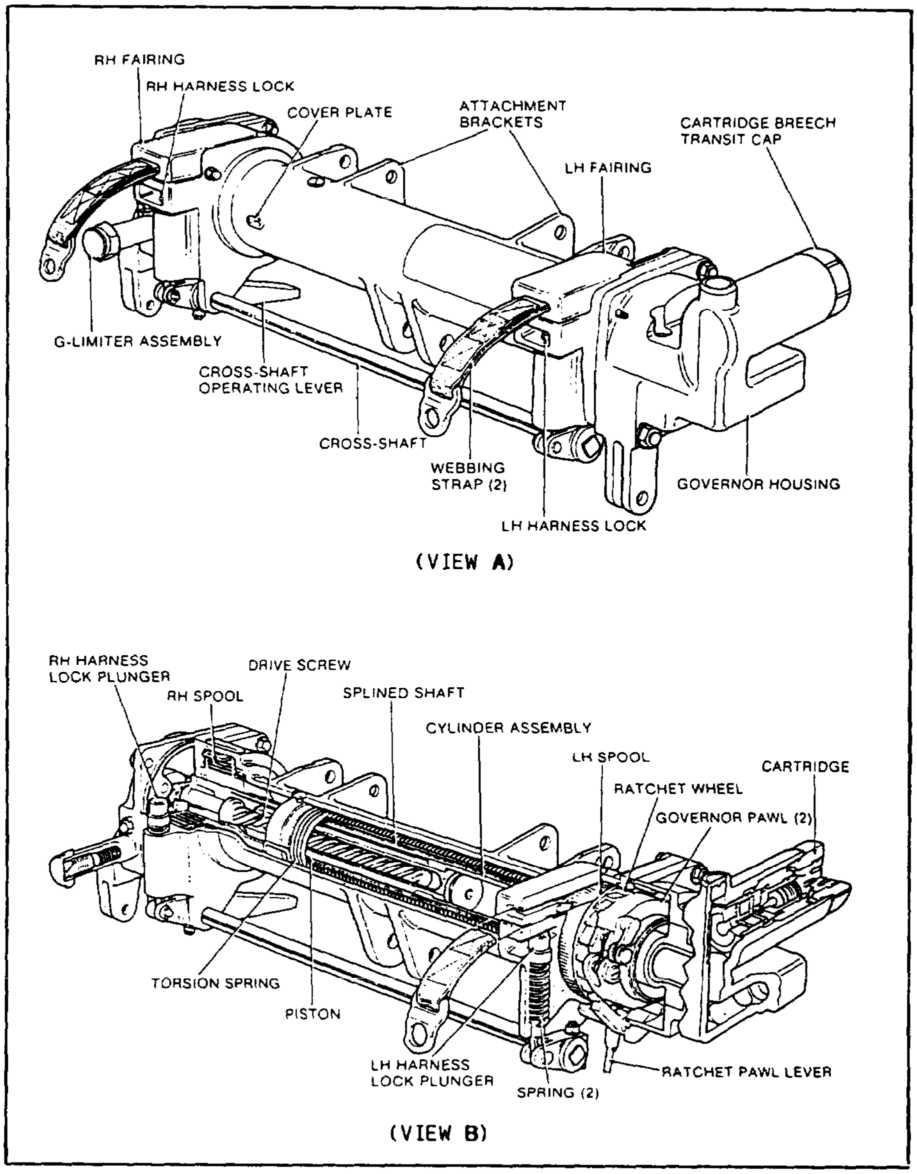


Figure 5-8.-View A, shoulder harness reel; view B, shoulder harness reel, sectioned view.

harness straps to retract but prevent them from extending. When in the normal unlocked state, automatic locks protect the occupant against rapid forward movement under high g-loading.

PARACHUTE DEPLOYMENT ROCKET MOTOR MK 122 MOD 0.— The parachute deployment rocket motor (PDRM) (fig. 5-9) is mounted on the LH main beam of the seat. When initiated by the sequencer, restraint release unit, or manual override (MOR) system, the PDRM extracts the personnel parachute from its stowage by means of a withdrawal line attached to the deployment sleeve.

The PDRM is a sealed unit. It consists of a cylindrical body that contains a gas-operated secondary cartridge in a breech at the lower end and a rocket with an integral gas-operated igniter cartridge in a barrel at the upper end. In a parallel connected chamber is an electrically initiated primary cartridge. A gas inlet is connected by a gas pipe to the harness release system.

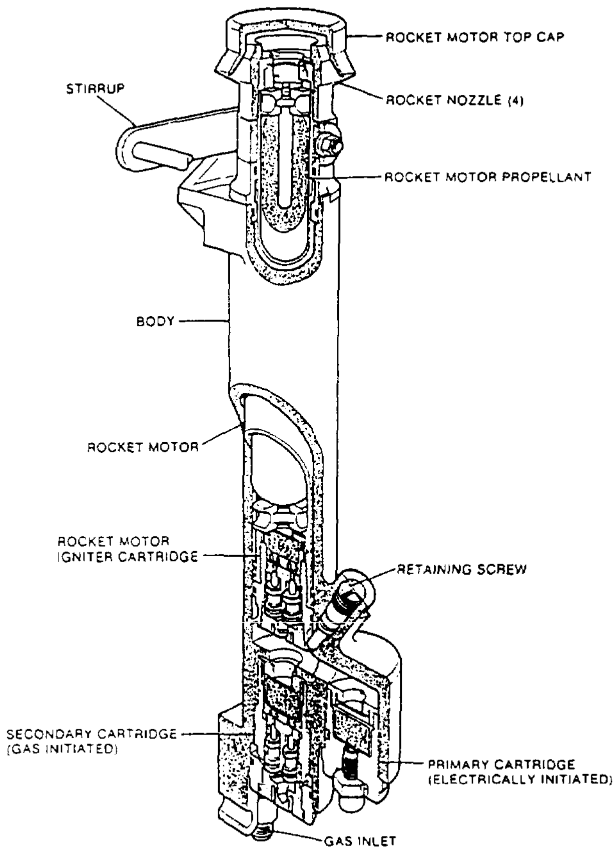


Figure 5-9.-Parachute deployment rocket motor (Mk 122 Mod 0).

Fitted around the rocket is a sliding stirrup, which is connected to the parachute withdrawal line and is free to slide down the rocket as it leaves the barrel.

ELECTRONIC SEQUENCER.— The NACES sequencer assembly (fig. 5-10) is composed of the sequencer, connectors to the interface with pitot static and dynamic pressure sources, and cable loom sleeving. It is mounted across the main beam assembly, below the parachute assembly. Upon activation, the sequencer determines the ejection mode and controls the functions of the drogue release, parachute deployment, and seat/man separation.

BAROSTATIC RELEASE UNIT (BRU).— The barostatic release unit (fig. 5-11) provides a housing for the cartridge that provides the gas flow to initiate harness release and parachute rocket deployment. The cartridge is activated either electrically by the sequencer or by the right-hand start switch (via the delay mechanism). The cartridge incorporates an aneroid capsule to prevent mechanical initiation above a preset altitude. The cartridge may also be initiated by operation of the MOR handle after ejection.

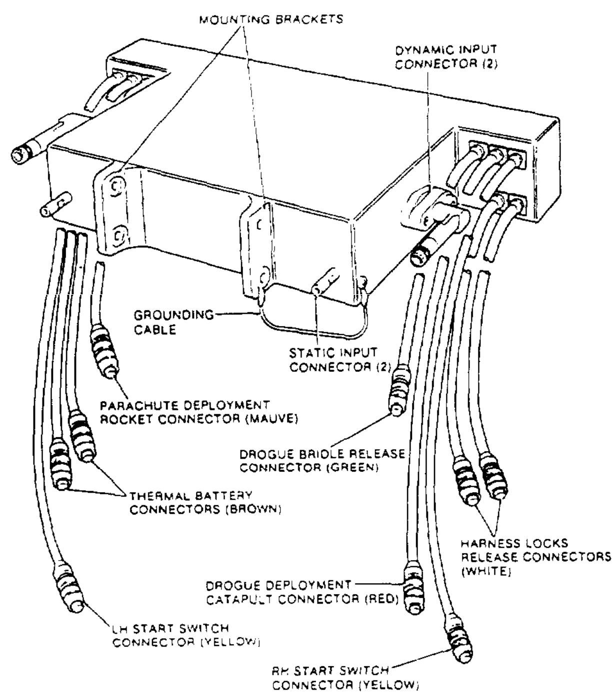


Figure 5-10.-Electronic sequencer.

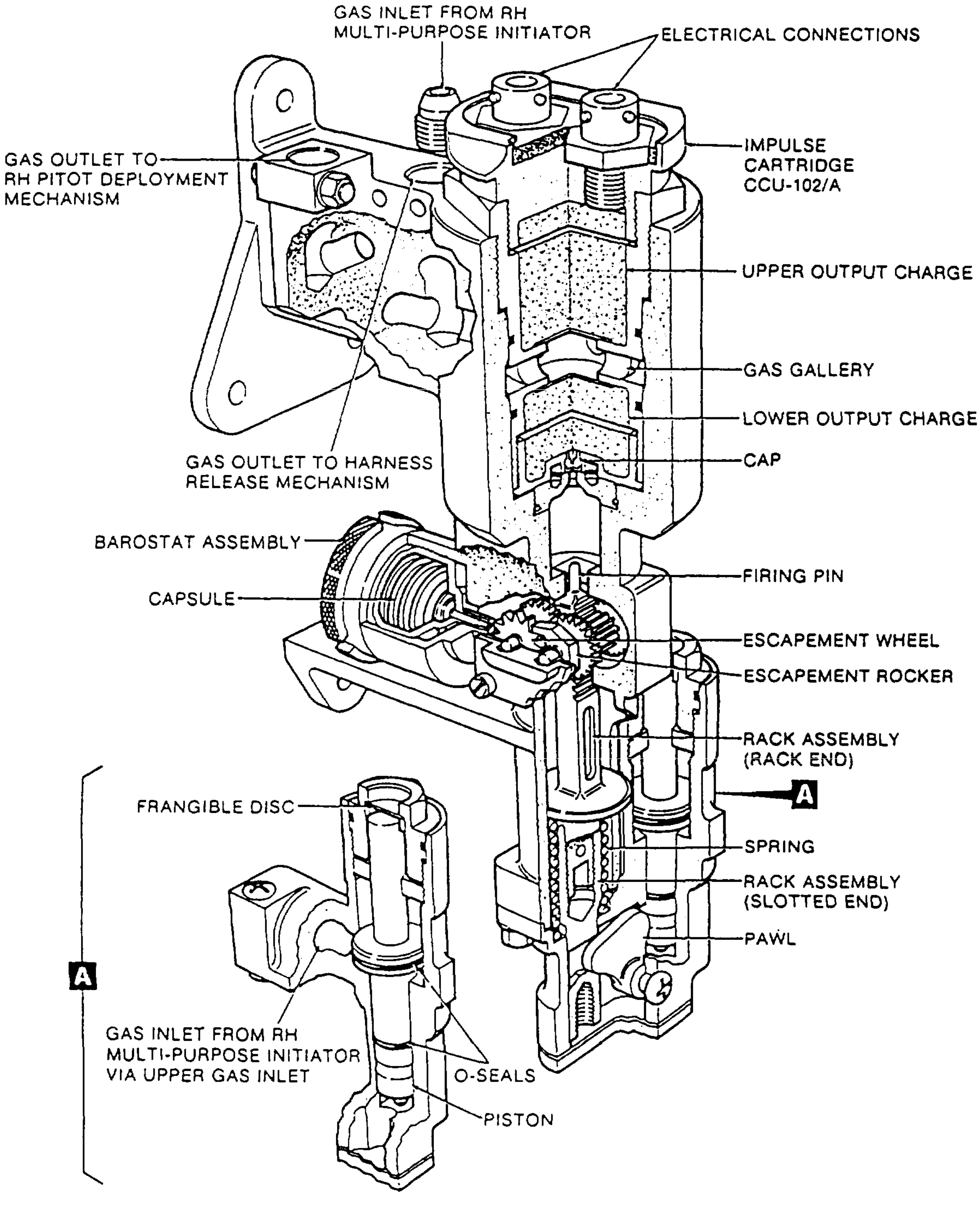


Figure 5-11.-Barostatic release unit.

Barostat Assembly.— The barostat consists of an aneroid capsule in a housing that is screwed into the release unit in a position that allows a peg attached to the capsule to engage a star wheel in the delay mechanism. At altitudes in excess of the barostat rating, the peg engages the star wheel and prevents the delay mechanism from operating. As altitude decreases, the capsule peg retracts and allows the mechanism to function.

Impulse Cartridge.— The impulse cartridge (CCU-102/A) provides the gas necessary for the functions of the restraint release assembly.

DROGUE DEPLOYMENT CATAPULT.— The drogue deployment catapult (fig. 5-12) is mounted outboard of the RH main beam of the ejection seat. Its function is to deploy the stabilization drogue and bridle assembly rapidly without becoming entangled with the seat. The firing of the drogue deployment catapult is controlled by the electronic sequencer to ensure that the seat has cleared the aircraft before the drogue is deployed. The drogue deployment catapult consists of a cylindrical body containing an electrically operated impulse cartridge (CCU-101/A), a two-piece telescopic piston assembly, and an enlarged upper end, into which is fitted a drogue and canister assembly.

The drogue and canister assembly contains a 1.45mm (57-inch) diameter ribbon drogue, pressure packed into a 210mm (8.25-inch) long light alloy cylinder, closed at the upper end. The canister assembly is closed by an end cap attached to the drogue strap. At the lower end of the end cap, a link assembly is attached by the same bolt that secures the drogue strap. When installed on the ejection seat, the link assembly attaches to the drogue bridle, and the canister assembly is retained in the body by a threaded locking ring. At the upper end of the catapult body is riveted a threaded ring on to which the locking ring is screwed when installing the drogue canister.

MULTIPURPOSE INITIATORS.— Two multipurpose initiators (IMP) (fig. 5-13) are attached to the lower outer faces of the seat's main beams. During the ejection sequence, the IMPs supply gas pressure to operate the barostatic release unit delay mechanism, the underseat rocket motor, the pitot deployment mechanisms, and the internally mounted start switch assemblies.

Each IMP comprises a body, machined and drilled to accept a start switch, a static lanyard

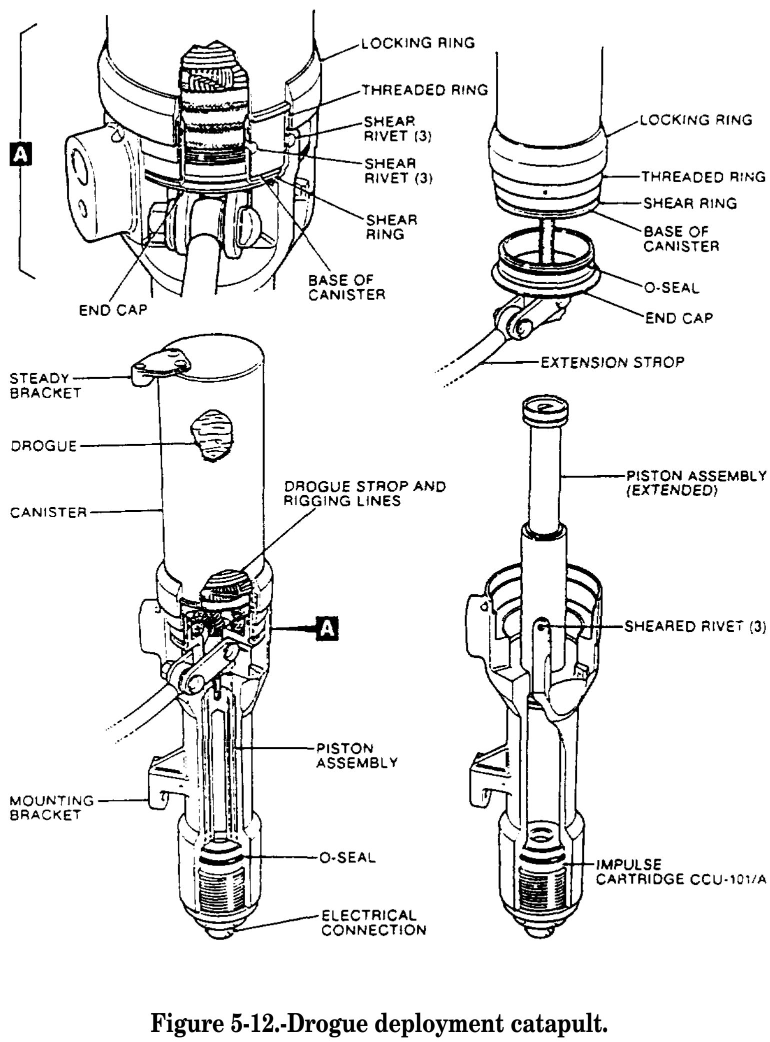


Figure 5-12.-Drogue deployment catapult.

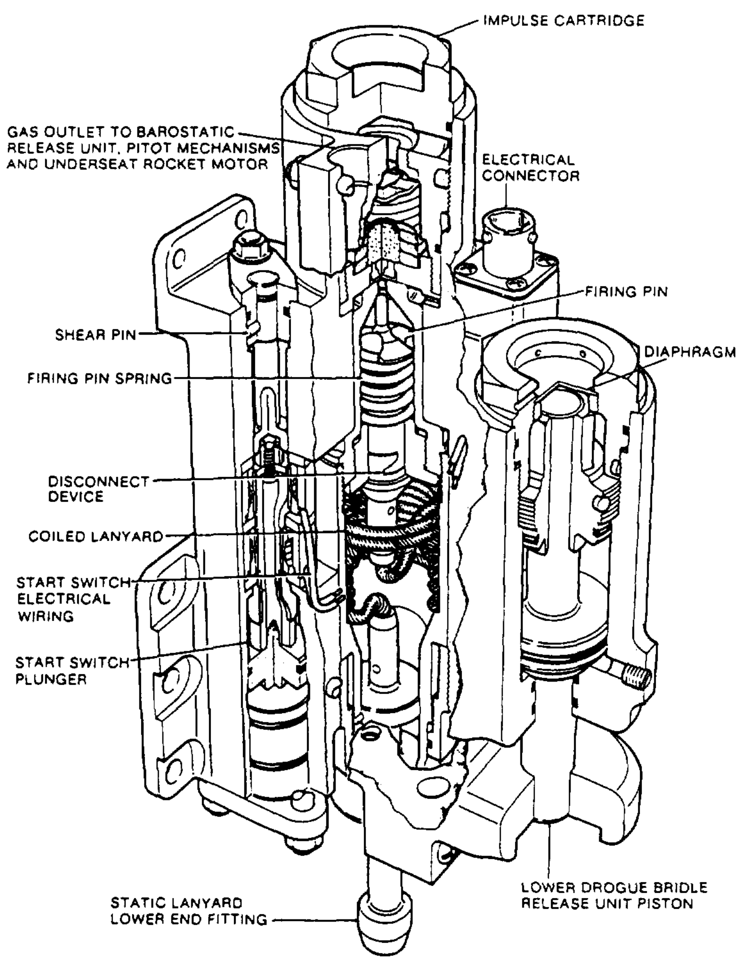


Figure 5-13.-Multipurpose initiator, left-hand.

assembly, a spring-loaded firing pin, and an impulse cartridge. A gas passage through the unit body connects the cartridge breech to the lower end of the start switch plunger. Incorporated into the unit body, but mechanically separate, is a lower drogue bridle release unit.

The static lanyard assembly comprises a lanyard, precoiled into a cylindrical container and with special fittings swaged on to each end. The upper end fitting incorporates a wedge-shaped disconnect device, which engages with the lower end (similarly wedge-shaped) of a spring-loaded firing pin positioned below the cartridge. The lower end fitting protrudes through the lower end of the body and is retained by a shear pin. When the seat is installed on a catapult, the protruding lower end fitting locates in one of the catapult-mounted ballistic latches.

The start switch assembly is installed vertically and comprises a series of metal sleeves and insulated sections to form an electrical switch assembly. An internal plunger is partially sleeved with insulating material, has a short gold-plated section, and incorporates a piston head at its lower end. Movement of the plunger before operation is prevented by a shear pin. Two start switch assemblies are incorporated into the multipurpose initiators. During ejection, the start switches supply a start signal to the sequencer at the correct time in the sequence.

The impulse cartridge is percussion operated by the firing pin and is screwed into a breech at the upper end of the body. A gas gallery machined in the upper part of the cartridge ensures even distribution of gas pressure when the cartridge fires.

TIME-DELAY MECHANISM.— The time-delay mechanism consists of a spring-loaded rack assembly in mesh with a gear train controlled by

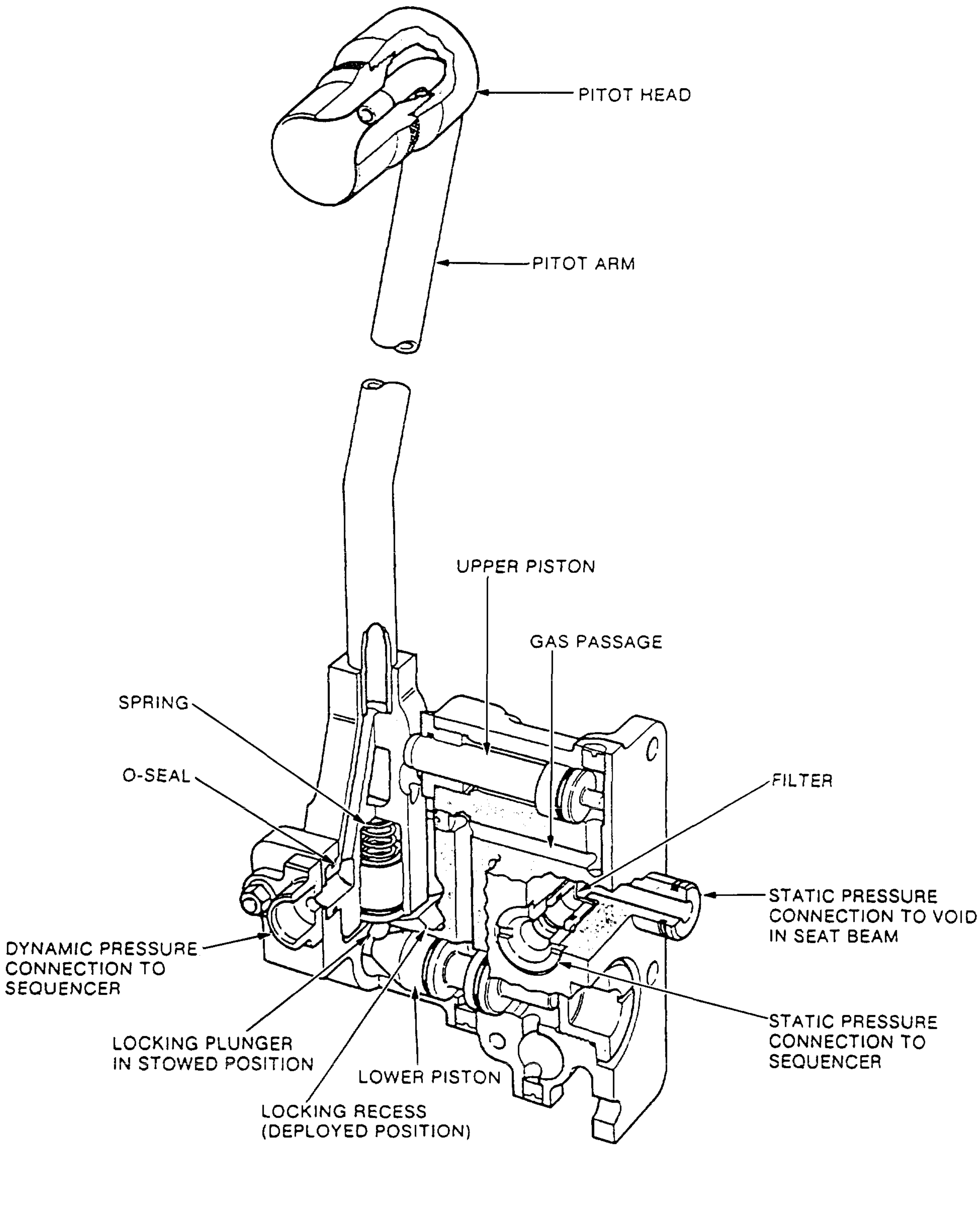


Figure 5-14.-Pitot assembly, right-hand.

an escapement. The gear train consists of a primary spur and pinion, a secondary spur and pinion, an idler wheel, an escapement wheel and an escapement rocker.

The rack assembly consists of a rack end screwed into a slotted end. The two components are secured together with a locking screw. The upper end of the rack end is shaped to form a firing pin.

To retain the rack in the cocked position, one face of a pawl in the bottom housing engages in the slotted end of the rack assembly. Another face of the pawl engages in a groove in a gas-operated

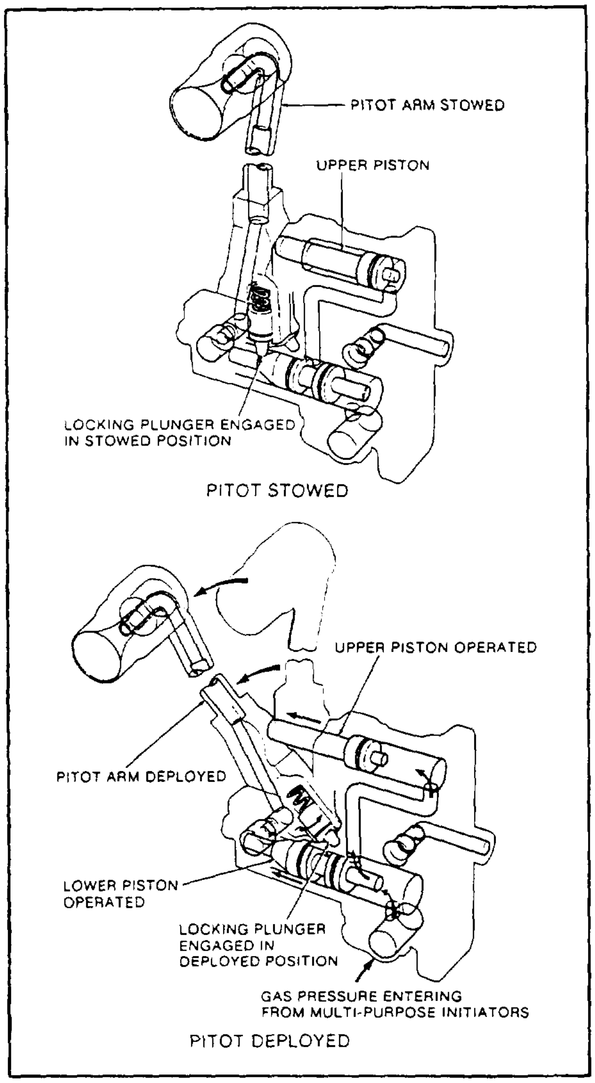


Figure 5-15.-Pitot assembly, operation.

piston installed in a housing attached to the lower part of the unit body. The piston is retained in position by a frangible disc.

PITOT ASSEMBLIES— Two pitot assemblies (figs. 5-14 and 5-15) incorporating deployable pitot heads are mounted on the main beams behind the parachute container. Removable covers are provided to prevent entry of foreign bodies,

The pitot heads are maintained in the stowed position by locking mechanisms that are released during seat ejection, as the seat separates from the catapult, by gas pressure from the multipurpose initiator cartridges. When deployed, the pitot head assemblies supply dynamic pressure inputs to the electronic sequencer. Static (base) pressure is supplied to the sequencer from the voids within the LH and RH main beams.

Each pitot assembly comprises a body, drilled and plugged to form a series of gas passages, and two cylinders containing upper and lower pistons. A deployable pitot arm incorporating a pitot head is attached to the aft face of a bracket, forming part of the body. Attached to the forward face of the bracket is a pitot connector that is connected to the pitot head. A spring-loaded locking plunger, which locates in one of two holes in the body, is installed inside the lower end of the pitot arm. The locking plunger locks the pitot arm in the stowed or deployed positions. A separate passage in the body, incorporating connectors at each end and a filter, forms part of the static pressure supply system for the sequencer.

BALLISTIC MANIFOLDS.— There are two ballistic manifold assemblies-right-hand and left-hand.

Manifold Assembly Right-Hand.— The right-hand (RH) assembly is a gas distribution center that is connected to the seat bucket trombone tubes and incorporates the upper harness release piston, the ejection gas line quick disconnect, and a housing for the bridle release cartridge. The assembly also provides a mounting for a delay cartridge. The drogue bridle release impulse cartridge is installed in a threaded housing on the upper face. The upper harness release piston protrudes from the manifold upper face.

The lower face of the RH ballistic manifold (fig. 5-16) has four connectors. Two of these connectors accommodate the RH seat initiation trombone tube (outboard) and the harness locks to release the trombone tube (inboard). The connections are secured by a key-operated, quick-release pin that passes through a hole in the manifold and cutouts in the trombone tubes. The other two connectors accommodate the gas pipe from the barostatic release unit and the gas pipe to the lower drogue bridle release mechanisms.

Manifold Assembly Left-Hand.— The left-hand (LH) assembly is a gas distribution center that is connected to the seat bucket trombone tubes and houses a seat rocket initiation system check valve. The assembly also provides a mounting for a delay cartridge.

The upper face of the LH ballistic manifold (fig. 5-17) has three socket connectors, to which are connected a flexible hose to the LH pitot deployment mechanism, a rigid pipe from the RH multipurpose initiator, and a delay initiator.

The lower face of the LH ballistic manifold has three socket connectors. Two of these connectors accommodate the LH seat initiation trombone tube (outboard) and the underseat rocket motor trombone tube (inboard). The other connector accommodates a gas pipe to the thermal batteries. A bracket on the front face of the manifold accommodates the shoulder harness control mechanism torque shaft. A connection on the aft face accepts a gas pipe from the LH multipurpose initiator.

THERMAL BATTERIES.— Two thermal batteries (fig. 5-18) supplying power for sequencer operation are mounted together in a manifold on the LH main beam.

Seat Bucket Assembly

The seat bucket assembly (fig. 5-19) fits onto the lower portion of the main beams and

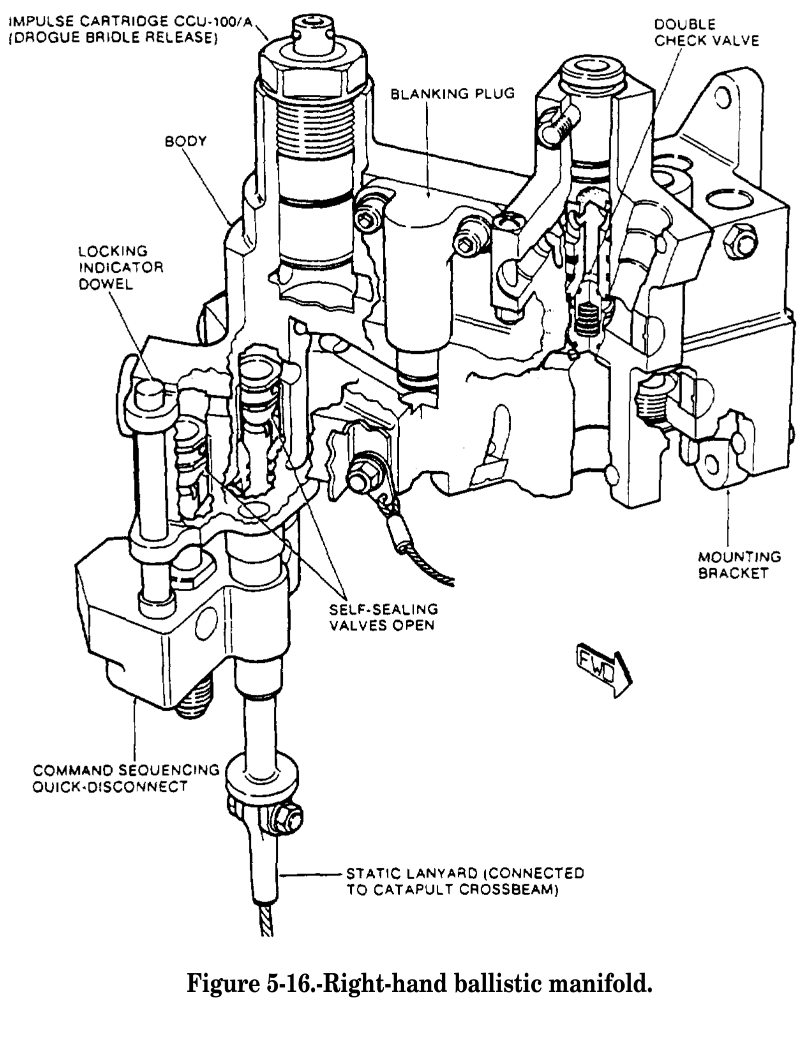


Figure 5-16.-Right-hand ballistic manifold.

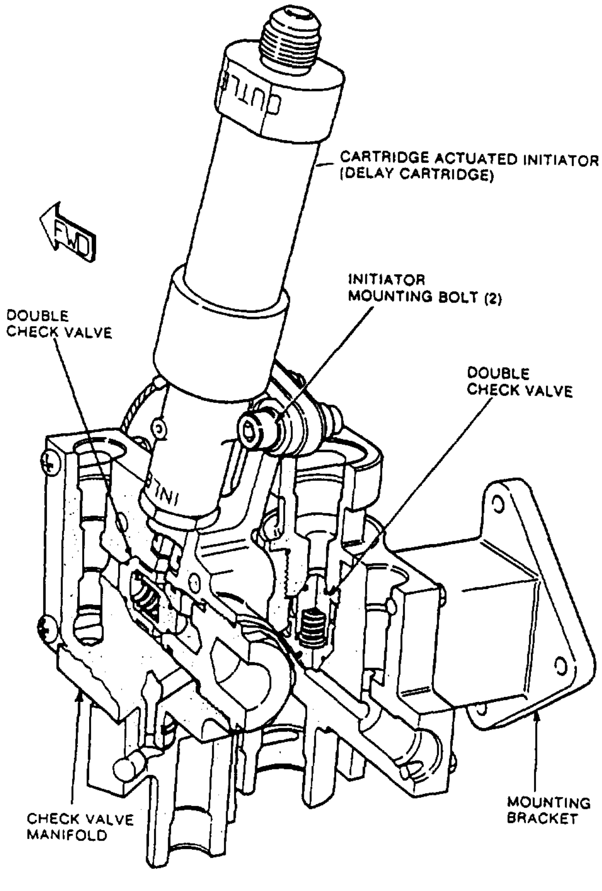


Figure 5-17.-Left-hand ballistic manifold, (F/A-18D).

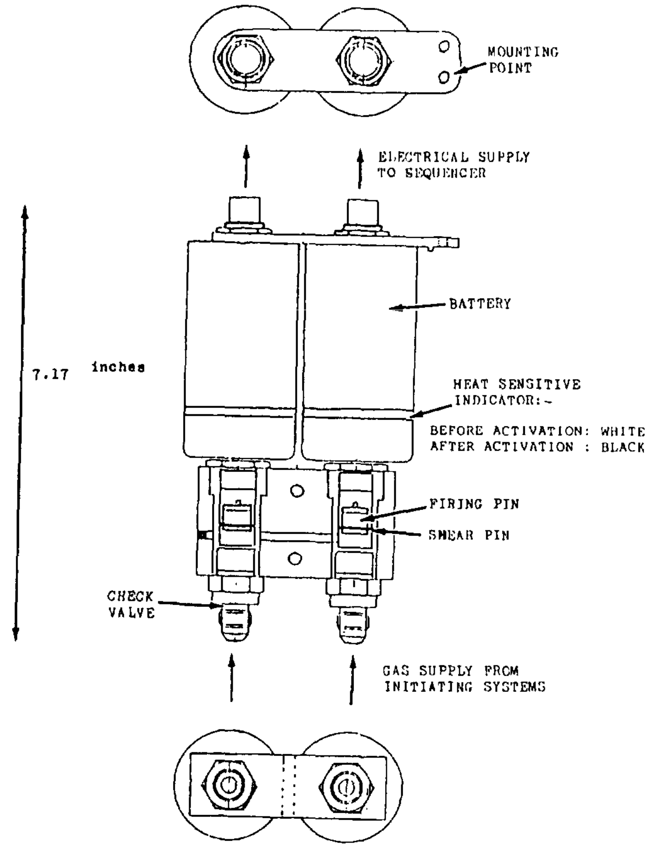


Figure 5-18.-Thermal battery assembly.

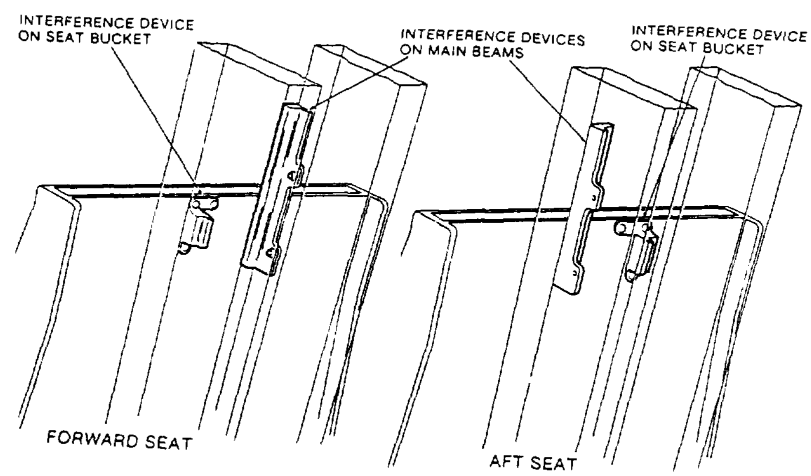


Figure 5-19.-Seat buckets to main beams.

mechanisms and provides a mounting for the survival kit assembly, rocket motor, and backpad assembly. The seat bucket assembly is configured for a particular seat by adding application-peculiar components, such as a seat height actuator. The bucket is secured by four nuts to studs incorporated into sliding runners on the seat's main beams. Interference devices on the rear of the seat bucket and on the main beams assembly ensure that only the correct seat bucket is installed in forward and aft cockpits.

The back of the seat bucket contains a rigid, molded pad that forms the back rest. It is contoured so that when the seat occupant is automatically pulled back by the shoulder harness reel when ejection is initiated, he/she assumes the correct posture. A cushion attached to the backrest provides additional comfort for the seat occupant.

Contained within the lower rear corners of the seat bucket are the lower harness locks and release mechanism. These are connected by a cross shaft and connecting links to the leg restraint line locks located in the side plates. The same connecting links connect the negative-g strap lock that is situated in the floor of the seat bucket to the rear of the seat firing handle. Half way up the inner face of the seat bucket sides are sticker clips. The pin puller is mounted at the rear of the seat bucket on the lower right-hand side (fig. 5-2).

UNDERSEAT ROCKET MOTOR.— The underseat rocket motor (fig. 5-20) is a sealed unit and consists of a manifold (machined, drilled, and threaded to accept ten propellant tubes), a lateral thrust motor tube, a cartridge tube, and four efflux nozzles. The propellant tubes are

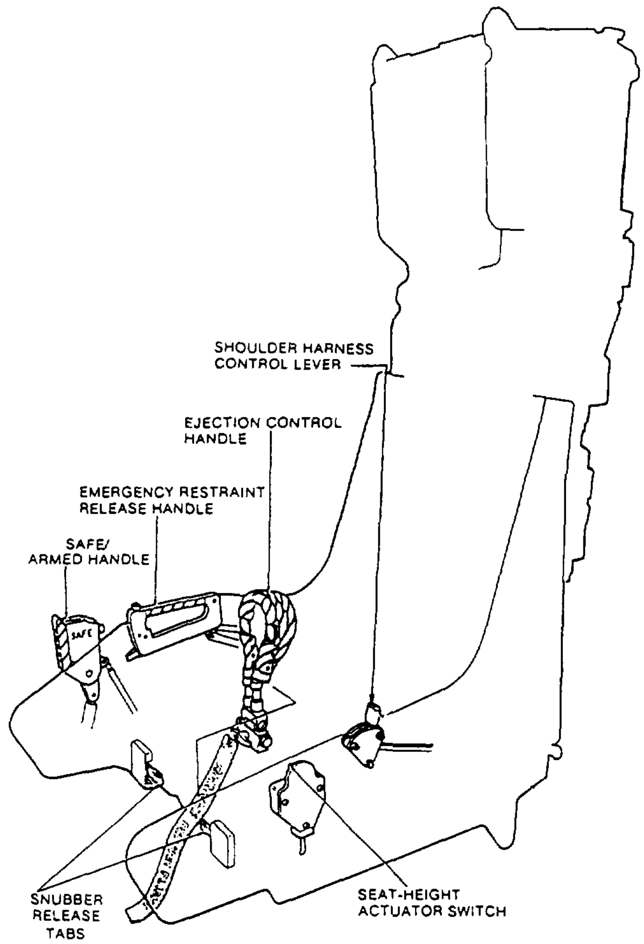


Figure 5-21.-Operating controls.

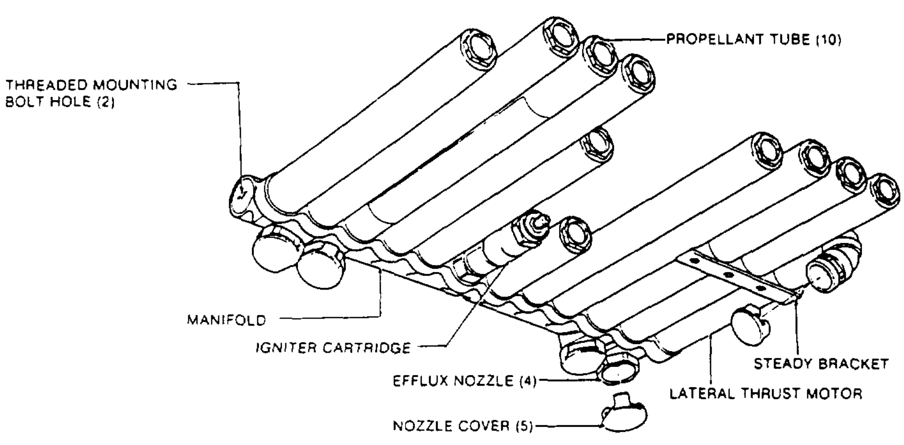


Figure 5-20.-Underseat rocket motor Mk 123 Mod 0 (forward seat).

manufactured from seamless steel. The tubes contain solid propellant drilled lengthwise through the center and having three equally spaced ribs to provide rapid and even burning. A cross-shape grid is positioned between the propellant and the manifold to ensure that the gas generated can pass unrestricted to the manifold. The cartridge tube is internally threaded to accept a gas-operated igniter cartridge incorporating twin firing pins and twin primers. A lateral thrust motor with an integral cartridge is screwed into the manifold at the LH end (forward seat) or RH end (aft seat). The efflux nozzles are fitted under the manifold and are sealed at the inner end by flanged blow-out discs, which cause a pressure build-up to ensure rapid and even burning of the propellant and an even thrust from the motor. Threaded holes in the manifold end plugs and a steady bracket clamped to the lateral thrust motor are used to secure the motor under the seat bucket, The threaded holes in the manifold end plugs vary in size between forward and aft seats to ensure location in the correct cockpit.

LATERAL THRUST MOTOR.— The lateral thrust motor (fig. 5-20) forms an integral part of the main rocket motor, being screwed into the manifold. An igniter cartridge is initiated by gas pressure from the rocket motor propellant and ignites the propellant in the lateral thrust motor to permit a divergent trajectory to the ejected seat.

EJECTION CONTROL HANDLE.— The ejection control handle (figs. 5-21 and 5-22) is located on the front of the seat bucket. It is the only means by which ejection can be initiated. The handle is molded in the shape of a loop, and is connected to the sears of the ejection seat initiators. The seat initiators have two rigid lines that connect to the trombone fittings. An upward pull of the loop removes both sears from the dual initiators to initiate ejection. Either initiator can fire the seat. After ejection the handle remains attached to the seat. The ejection control handle is safetied by using the ejection seat safe/arm handle and safety pin.

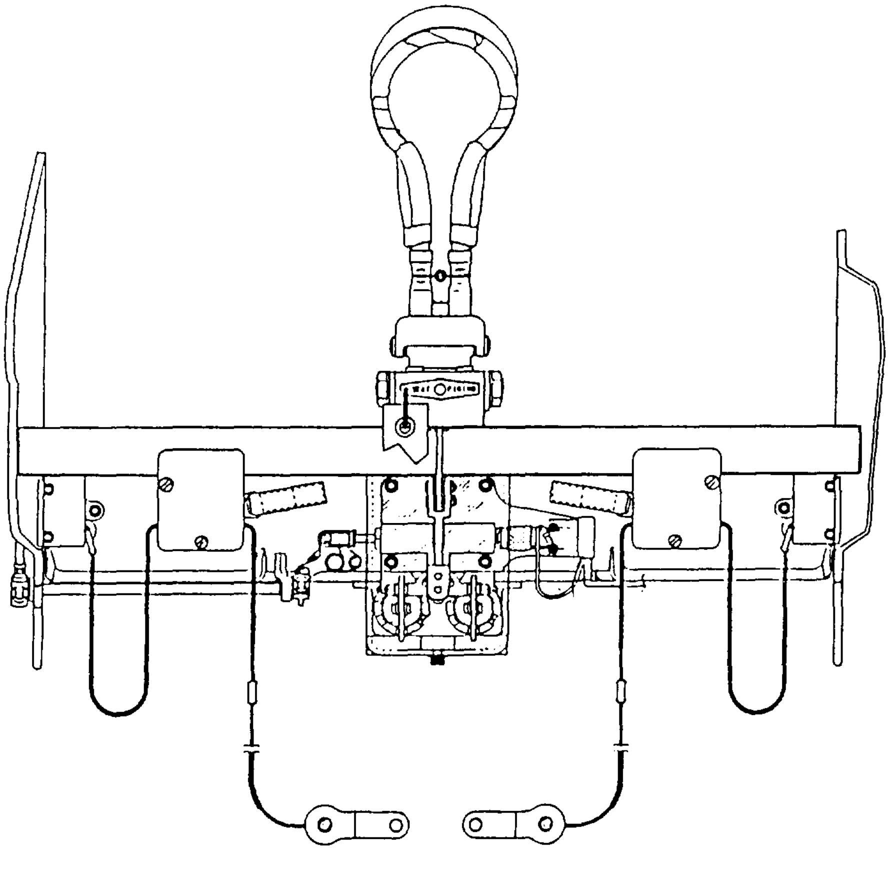


Figure 5-22.-Ejection control handle.

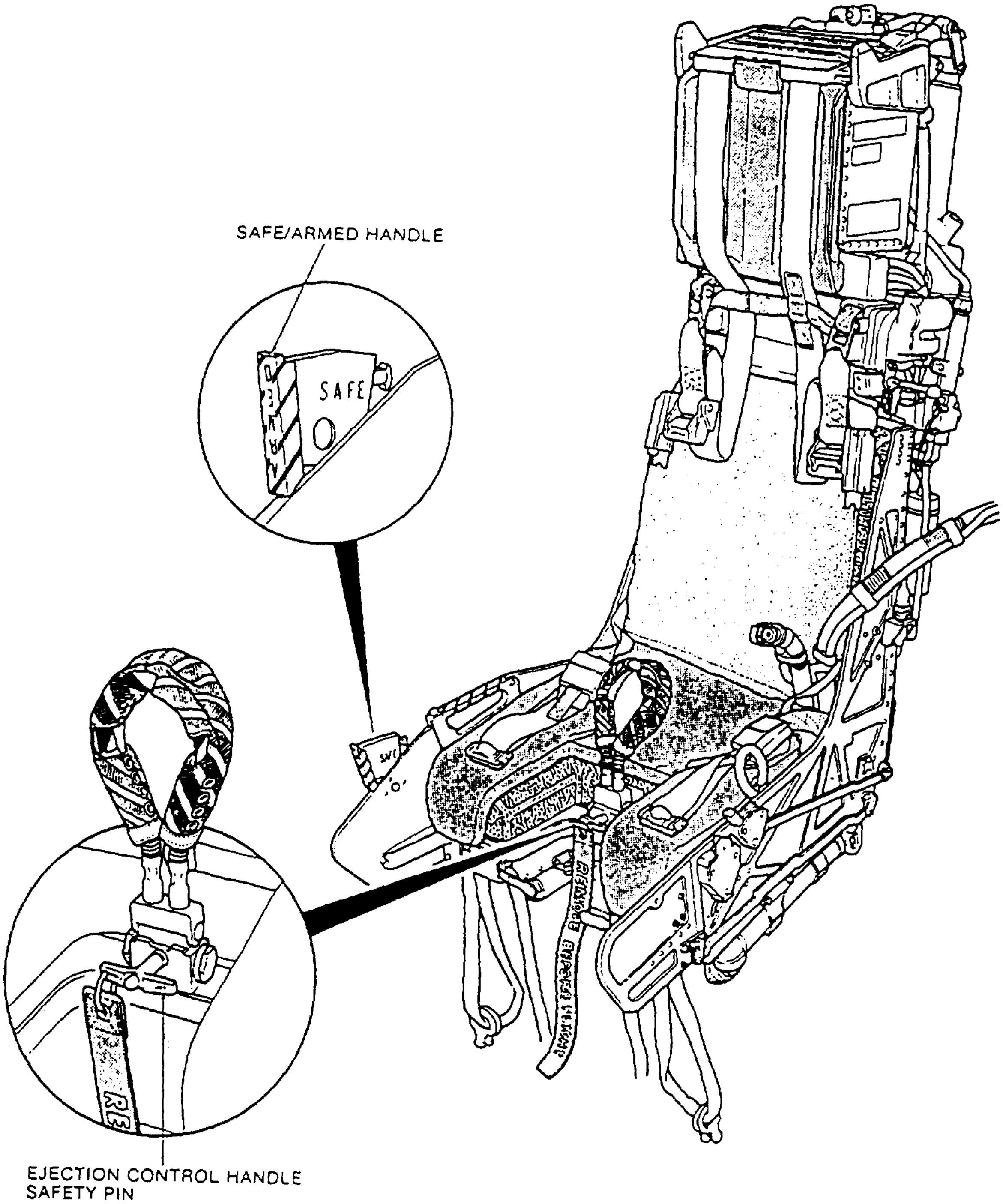


Figure 5-23.-Locations of safety devices.

SAFE/ARMED HANDLE.— The SAFE/ARMED handle (figs. 5-21 and 5-23) is located on the RH side of the seat bucket immediately forward of the emergency restraint release handle. Contained within the handle is a catch that locks the handle in either the ARMED or SAFE position. The handle is connected to a linkage that terminates in a safety plunger, which passes through the link of the ejection control handle when the handle is in the SAFE position and prevents operation of the ejection control handle. When in the ARMED position, the visible portion of the handle is colored yellow and black stripes and engraved ARMED; when in the safe position, the visible portion is colored white and engraved SAFE. An electrical visual SAFE/ARMED indicator is incorporated in the cockpit central warning panel, and is operated by a microswitch actuated by the safety plunger.

LEG RESTRAINT SNUBBERS.— Two leg restraint line snubbers (fig. 5-24), each with a leg restraint line, are attached to the front face of the seat bucket. Release of the leg restraint line snubbers to adjust the leg lines is effected by pulling inboard on the fabric loops attached to the release plungers on the inboard side of each snubber. The leg restraint lines taper plugs are secured in locks positioned on the seat bucket side plates.

EMERGENCY RESTRAINT RELEASE HANDLE.— The emergency restraint release

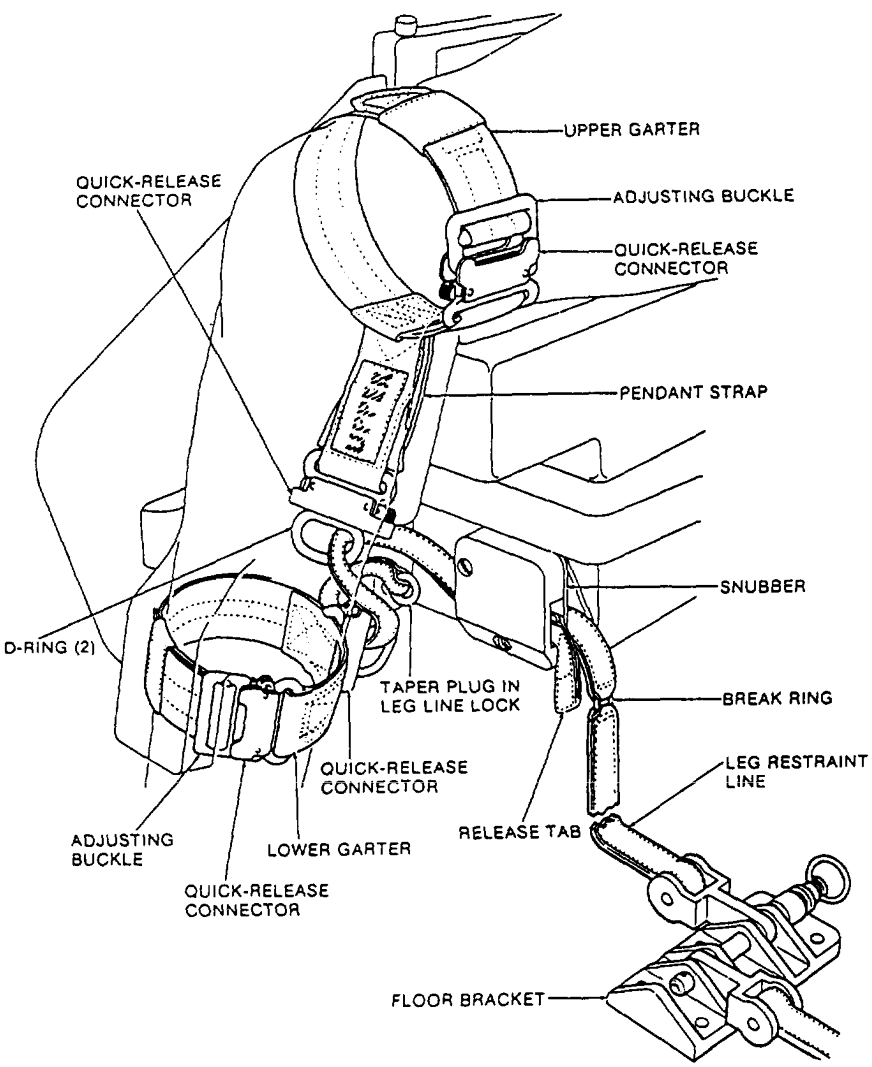


Figure 5-24.-Leg restraint system.

handle (figs. 5-21, 5-25, and 5-26) is connected by two link assemblies to the lower harness lock release mechanism and to a firing mechanism housed in the rear lower RH side of the seat bucket. The handle is locked in the down position by a catch operated by a thumb button situated at the forward end of the handle; depression of the thumb button allows the handle to be rotated rearward. Operation of the handle when the seat is installed in the aircraft is restricted by the pin puller, and releases only the lower torso restraint and leg restraint lines to permit emergency ground egress. On ejection, the pin puller is automatically disengaged from the handle operating link.

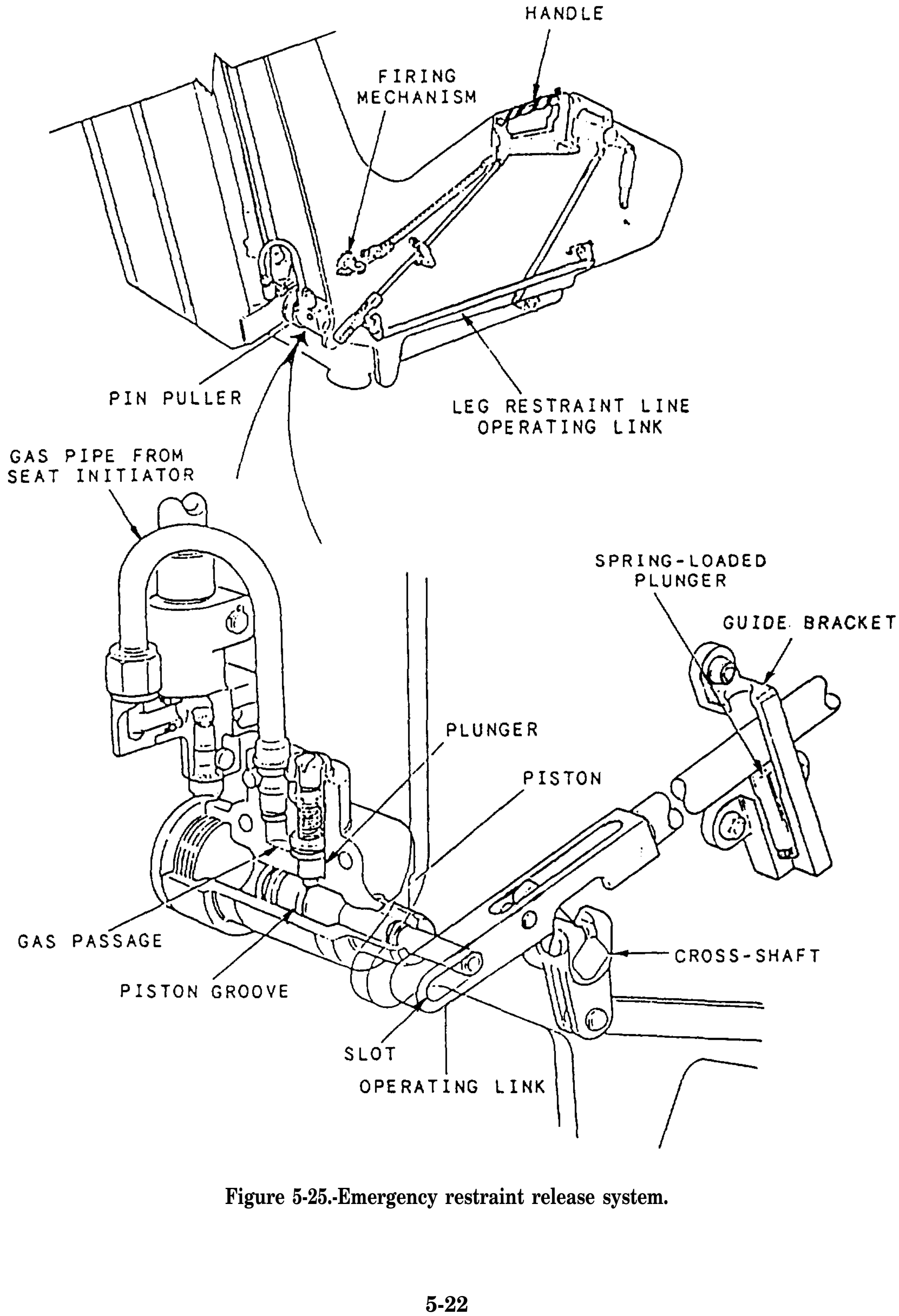


Figure 5-25.-Emergency restraint release system.

Operation of the emergency restraint release handle simultaneously operates the SAFE/ ARMED handle to the SAFE position. In the event of automatic sequence failure, operation of the emergency restraint release handle subsequent to ejection will fire a cartridge to operate the upper and lower harness locks and the parachute deployment rocket motor.

SHOULDER HARNESS CONTROL LEVER.– The shoulder harness control lever (fig. 5-21) is attached to the LH side of the seat bucket and is connected to the shoulder harness reel. When the lever is in the forward position, the shoulder harness reel is locked, preventing all forward movement of the seat occupant. When moved to the rear position, the seat occupant is free to move forward and backward. Should the seat occupant move forward rapidly, however, the shoulder harness reel will lock and remain locked until the load on the webbing straps is eased.

SEAT HEIGHT ACTUATOR SWITCH.— The seat height actuator switch (fig. 5-21) is situated immediately forward of the shoulder harness control lever. Forward movement of the switch toggle lowers the seat bucket, and rearward movement raises the seat bucket. When released, the toggle assumes the center OFF position.

PIN PULLER.— The pin puller (figs. 5-25 and 5-26) is installed on the aft right side of the seat bucket. Full aft rotation of the manual override handle is prevented by the pin puller. A pin extended from the pin puller engages a slot in the manual override linkage. During the ejection sequence, gas pressure from the right-hand seat initiator cartridge retracts the pin.

LOWER HARNESS RELEASE MECHANISM.— The lower harness release mechanism (fig. 5-26) includes the two lower harness locks, the two leg restraint line locks, the negative-g strap lock, the emergency restraint release piston housing, and associated connecting levers and linkages.

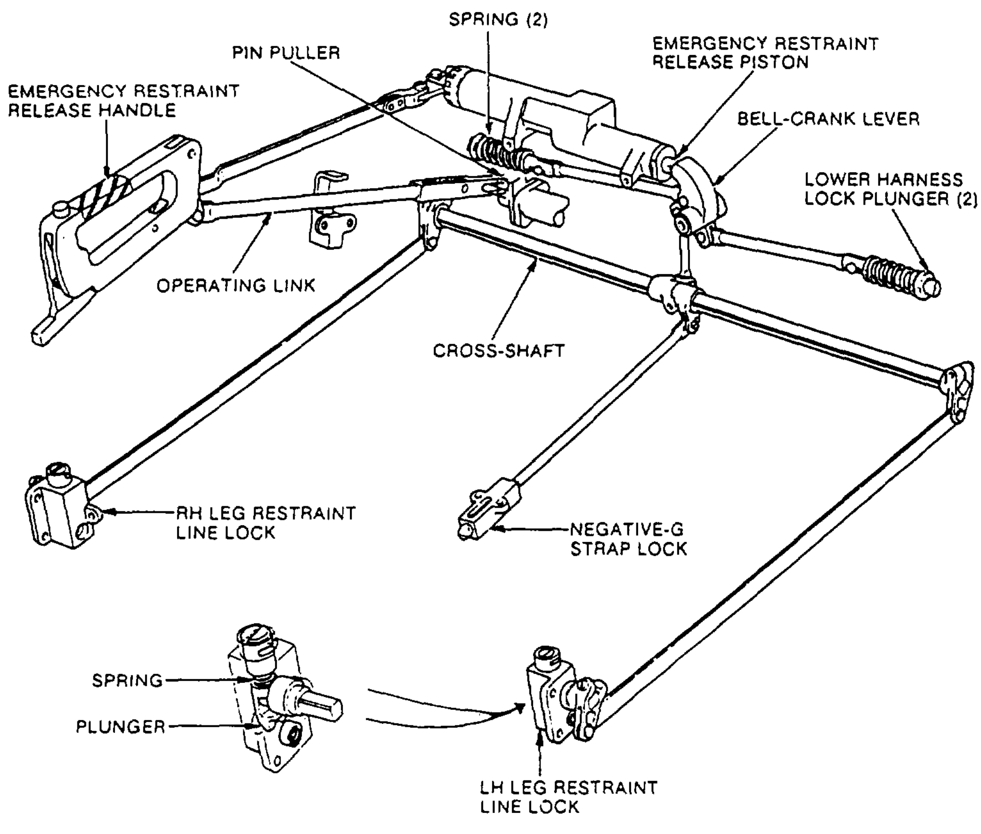


Figure 5-26.-Lower harness release mechanism.

Parachute Assembly

The parachute assembly (fig. 5-27) comprises a 6.2m (20-foot) GQ type 2000 personnel parachute packed, together with a ribbon drogue, into a rigid container and connected to the parachute risers. The parachute risers incorporate seawater activated release switches (SEAWARS) for attachment to the upper torso harness. These switches will automatically release the occupant from his/her parachute following descent into seawater. The parachute assembly is attached to the upper forward face of the ejection seat main beams. Some seats may contain the GQ-5000 type parachute, depending on date of manufacture.

PARACHUTE CONTAINER.— The parachute container is of light alloy construction, with canopy breakers fitted to each upper outboard side. The breakers on the forward seat are longer than those on the aft seat. Two hooked brackets on the lower rear face of the container locate over pins on the main beams. Brackets, integral with the rear of the canopy breakers, are bolted to brackets on the main beams. A shaped headpad is attached to the front face of the container to provide head location during ejection. A hook and pile fastener is fitted to the front face of the headpad to locate the parachute risers. The container is closed by a rigid top cover, with a single lug on the RH side and two lugs on the LH side. The LH lugs deform during parachute extraction, releasing the cover to permit rapid parachute deployment. A fairing on the LH rear corner of the cover protects the parachute withdrawal line where it leaves the container.

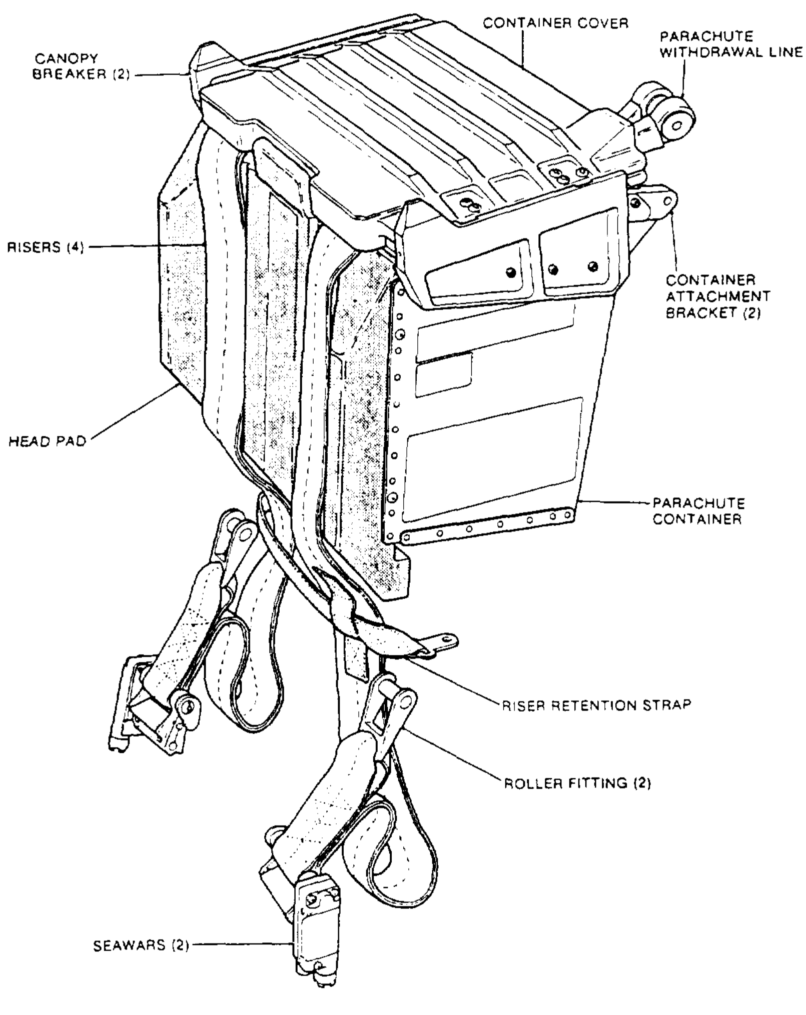


Figure 5-27.-Parachute assembly, forward seat.

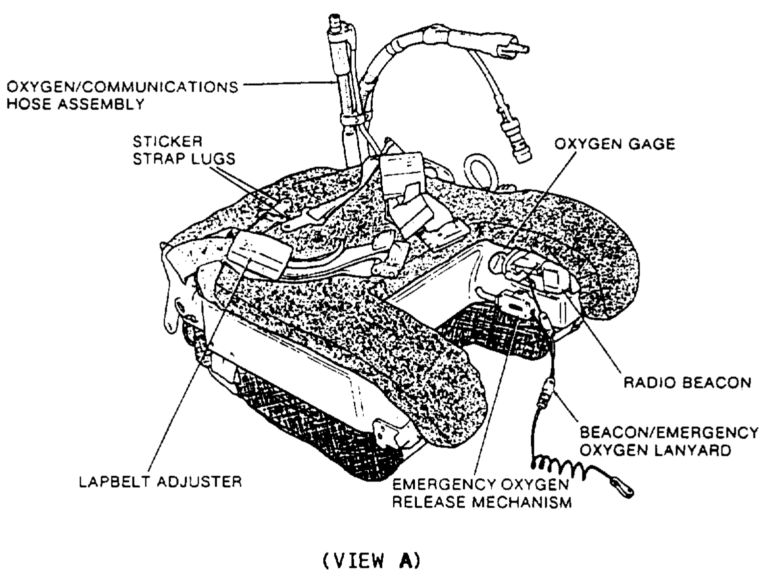
PARACHUTE CANOPY AND DROGUE.— The parachute canopy incorporates a crown bridle, at the apex of which is attached, via a short strap, a 1.5m (60-inch) ribbon drogue. The parachute canopy and drogue are packed, drogue first, into a deployment bag, the closed end of which is attached via a withdrawal line to the stirrup on the parachute deployment rocket.

Seat Survival Kit Assembly

The survival kit assembly (fig. 5-28) fits into the seat bucket and comprises a contoured rigid platform (lid assembly), to which are attached an emergency oxygen system and a fabric survival package. A cushion on top of the platform provides a firm and comfortable seat for the occupant.

The lid assembly is a rigid platform that incorporates the emergency oxygen system and lap belts. The lid assembly also provides stowage for the radio beacon and mountings for the rucksack assembly. The lid assembly is retained in position in the seat bucket by brackets at the front and lugs secured in the lower harness locks at the rear, Attached to the lugs are two adjustable lap belts with integral quick-release fittings.

EMERGENCY OXYGEN SYSTEM.— An emergency oxygen cylinder, a pressure reducer, and associated hardware are mounted on the underside of the lid assembly. A green manual-operating handle is mounted on the LH side of the assembly, and a cylinder contents gauge is on the inside face of the left-hand thigh support. The



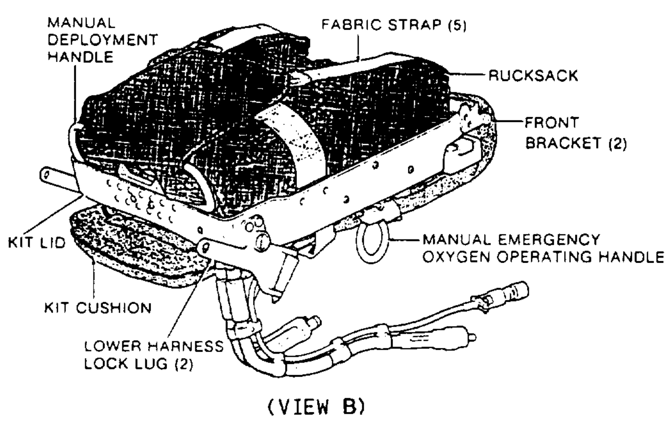


Figure 5-28.-Seat survival kit assembly; (A) top view; (B) bottom view.

emergency oxygen system is automatically activated during ejection by a lanyard connected to the cockpit floor. An oxygen/communications hose is connected to unions on the LH rear top of the lid assembly, and provides connections between the seat occupant and the aircraft and survival kit systems.

RADIO LOCATOR BEACON.— A URT-33A radio locator beacon is located in a cutout in the left thigh support. The beacon is actuated during ejection by a lanyard connected to a common anchorage point with the emergency oxygen lanyard.

RUCKSACK ASSEMBLY.— The rucksack assembly is attached to the underside of the lid assembly by five fabric straps and a double cone and pin release system. The rucksack contains a life raft and the survival aids. Yellow manual deployment handles mounted on the kit enable the occupant to deploy the rucksack and contents onto a lowering line after seat/man separation. The LRU-23/P life raft inflates automatically on rucksack assembly deployment.

COMPONENT OPERATION

The operation of each component and subsystem is discussed in the following paragraphs. The operation of the system as a whole is discussed later in the chapter.

Catapult Assembly

Explosive charges are contained in an ejection gun initiator, JAU-56/A (figs. 5-3 and 5-4), and a secondary cartridge. Gas pressure from the seat firing system or the aircraft command sequencing system operates twin firing pins in the ejection gun initiator to fire the explosive charge.

Gas enters the manifold valve through one or both of the inlet ports, depresses the check valves, and passes down through the vertical bore into the initiator. Gas pressure acts upon the twin firing pins in the initiator, shearing the shear pins and forcing the firing pins down to strike the percussion caps and ignite the explosive filling. The gas pressure generated within the catapult—

1. Passes to the ballistic latches to operate the pistons, which retain the multipurpose initiator static lanyards.
2. Propels the catapult piston upwards. The initial movement of the piston forces the spring-loaded top latch plunger out of the breech groove back into the barrel latch (fig. 5-4). The piston continues to rise, thrusting against the top crossbeam of the seat, the upward movement causing the shaped end of the top latch plunger to ride out of, and disengage from, the barrel latch. Further upward movement of the piston uncovers the secondary cartridge, which is fired by the pressure and heat of the initiator gas. After approximately 38 inches (965mm) of travel, the piston head strikes the guide bushing and shears the three dowel screws. After a further 4 inches (101mm) of travel, the piston separates from the barrel and moves away with the ejected seat.

Main Beams Assembly

The main beams assembly supports the major components of the ejection seat. The operation of the components supported by the main beams assembly is discussed in the following paragraphs.

SHOULDER HARNESS CONTROL SYSTEM.— When the ejection control handle is pulled, gas from the RH seat initiation system is piped into the breech to operate the cartridge. The gas also passes to the operating piston in the governor housing, forcing it upwards to operate the trip lever and bring the locking pawl into contact with the ratchet wheel.

The gas from the impulse cartridge in the breech impinges on the end of the piston forcing it along the cylinder. Horizontal movement of the piston is transmitted via the threaded drive screw to rotate the splined shaft, spool assemblies, and ratchet wheel, which winds in the webbing straps to pull back and restrain the occupant's shoulders. The engaged locking pawl locks the spools in the restrained position.

Withdrawal of the webbing straps at excessive speed causes the two governor pawls to rotate outwards under centrifugal force and engage the teeth on the housing, preventing rotation of the splined shaft and spool assemblies and further withdrawal of the straps. This system prevents the occupant from being thrown forward on crash landing or sudden deceleration if the shoulder harness control lever is in the disengaged position. Easing of tension on the webbing straps allows the pawl springs to reassert themselves and disengage the pawls from the teeth, permitting free withdrawal of the straps again.

PARACHUTE DEPLOYMENT ROCKET MOTOR.— Upon seat ejection, gas pressure from the primary and secondary cartridges passes to the rocket igniter cartridge to fire the rocket, shearing the flange of the rocket igniter cartridge. As the rocket moves upward, the stirrup slides down the rocket and aligns itself directly below the thrust axis line to extract and deploy the personnel parachute.

In the event of sequencer failure, gas entering the unit through the gas inlet ports from the harness release unit cartridge or the emergency restraint release cartridge will initiate the secondary cartridge to face fire the primary.

ELECTRONIC SEQUENCER.— When the ejection seat is fired, two onboard thermal batteries are immediately energized, supplying usable electrical power to the sequencer after just 100 milliseconds, with the seat having travelled about 5 inches up the ejection catapult. The sequencer's microprocessors then run through an initialization routine, and by 120 milliseconds the sequencer is ready and waiting to perform.

As the seat rises from the cockpit, two steel cables (approximately 42 inches) are pulled from the multipurpose initiators, actuating two pyrotechnic cartridges. The gas generated by these two cartridges is piped around the seat to perform the following functions:

- Initiate the underseat rocket motor.
- Deploy the pitot tubes from the sides of the seat headbox.
- Close two electrical switches (sequencer "start" switches).

The sequencer responds to the closure of either start switch by changing to the "ejection" mode. The switch starts an electronic clock, and all subsequent events are timed from this point. In the absence of a start switch signal, the sequencer will simply continue in the "wait" mode. This mode is a safety feature designed to ensure that the drogue and parachute can only be deployed after the seat has physically separated from the aircraft.

The ignition of the underseat rocket motor is timed to occur just as the seat separates from the ejection catapult, at about 200 milliseconds, so as to maintain a uniform vertical acceleration profile on the seat and occupant. The motor has a burn time of 250 milliseconds. Once the sequencer is switched into the "ejection" mode, its first action is to electrically fire the drogue deployment canister, which occurs precisely 40 milliseconds after start switch (approximately 220 milliseconds from seat initiation), while the seat rocket motor is burning. This happens regardless of the speed and altitude conditions.

The sequencer then enters its most crucial period, when it will sense the seat's airspeed and altitude and choose the appropriate timings from a set of five available sequences. This is done during a 60 millisecond "environmental sensing time window" that starts just after the drogue canister is fired, and is completed before the drogue is fully deployed and pulling on the back of the seat. The sequencer measures the speed and altitude from the information it receives from three types of sensor: pitot pressure, base pressure, and accelerometer.

Several samples of each parameter are taken during the environmental window. These are used to determine the ejection conditions. The sequencer then selects the appropriate timings for the remaining events, known as "mode selection," and completes the sequence accordingly.

Overview of Sequencer Electronics and Hardware.— The electronic sequencer and its thermal batteries are packaged in two separate units. The sequencer and associated electronics are contained in a cast aluminum enclosure, which is mounted between the main seat beams directly beneath the parachute container headbox. A total of nine shielded cables attached to the housing transmit electrical signals to and from the sequencer. The input and output actions are as follows :

Input—

- thermal battery power supply lines (2)
- start switch circuits (2)

output—

- drogue deployment canister squib-fire circuit
- drogue bridle release squib-fire circuit
- parachute extractor squib-fire circuit
- seat harness release squib-fire circuit
- seat harness release (backup) squib-fire circuit

The sequencer also has air pressure couplings to connect it to the two pitot pressure tubes on the headbox and the two base pressure sensing points inside the main seat beams. A functional block diagram of the electronic circuitry is given in fig. 5-29.

Modes of Operation.— The operational envelope of the NACES is divided into five zones, each of which is associated with a particular timing sequence, known as modes. These timings provide the optimum seat performance under all ejection conditions, both in terms of maximizing the survivable escape envelope and minimizing the risk of occupant injury. Figure 5-30 shows the five zones on the speed versus altitude chart, and table 5-1 gives the corresponding squib-fire timings.

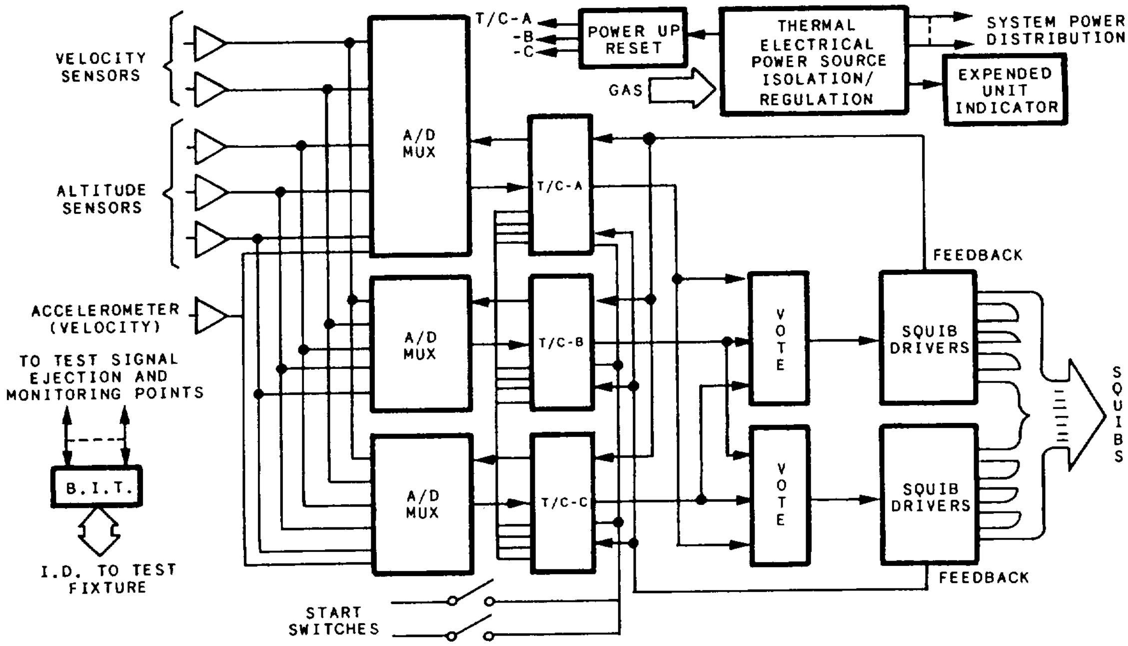


Figure 5-29.-NACES functional block diagram.

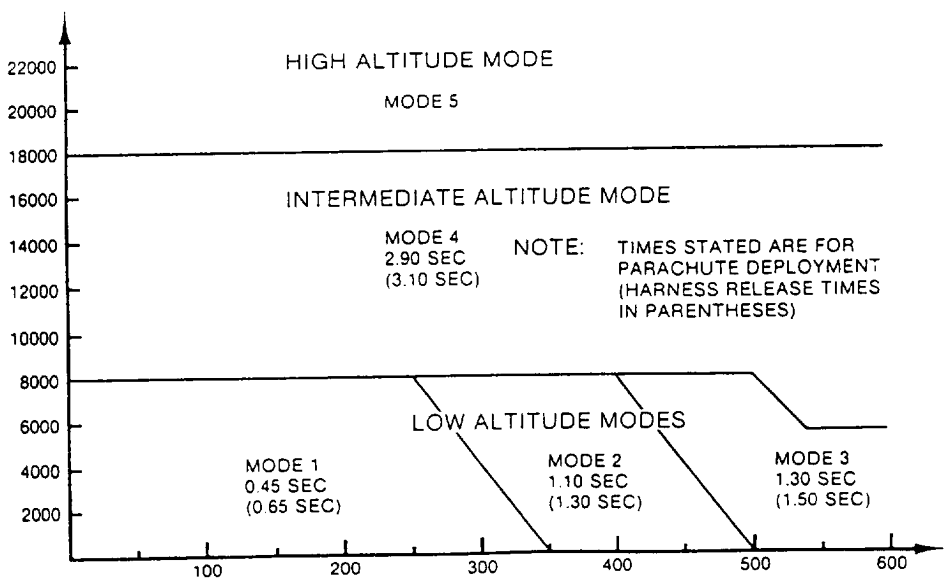


Figure 5-30.-Ejection modes.

Table 5-1.-Squib-Fire Event Times

SQUIB-FIRE EVENT TIMES
IN MODES 1 to 5

Altitude (ft)	0—8K			8K—18K	18K+
KEAS	0—350	350—500	500—600	ALL	ALL
MODE	1	2	3	4	5
1 Gas pressure from seat initiator cartridges, delay cartridge or command sequencing system initiates catapult and thermal batteries	0.00	0.00	0.00	0.00	0.00
2 Start switches close after 39 inches of seat travel	0.18	0.18	0.18	0.18	0.18
3 Sequencer supplies dual pulse to fire drogue deployment catapult	0.22	0.22	0.22	0.22	0.22
	Environmental sensing time window 0.245 — 0.305 seconds				
4 Sequencer supplies dual pulse to fire drogue bridle release cartridge and release drogue bridle	0.32	—	—	—	4.80 +t (See Note 3)
5 Sequencer supplies dual pulse to fire parachute deployment rocket	0.45	1.10	1,30	2.90	4.87 +t
6 Sequencer supplies dual pulse to fire drogue bridle release cartridge and release drogue bridle	—	1.25	1.45	3.05	—
7 Sequencer supplies dual pulse to fire barostatic release unit cartridge and release harness locks	0.65	1.30	1.50	3.10	5.07 +t
8 Sequencer supplies dual pulse to fire barostatic release unit cartridge (backup)	0.66	1.31	1.51	3.11	5.08 +t

All times are references to ejection seat initiation. The start switches operated approximately 0.18 seconds after initiation. N. B: This is a nominal time. The actual time will vary between 0.13 and 0.19 seconds.

In Mode 5 operation, altitude sensing is to recommence at 4.80 seconds, continuing until fall-through-condition (below 18,000 ft) is detected.

t = time interval between 4.80 seconds and fall-through-condition.

Mode 1 is designed for low-speed/low-altitude ejection conditions. The aim is to deploy the main parachute as soon as practicable after the seat has separated from the aircraft. A drogue deceleration phase is not required so the bridle releases are operated very quickly, thus ensuring that the deploying drogue and bridle assembly moves rapidly clear of the seat in readiness for the immediate main parachute deployment.

Modes 2, 3, and 4 cater for high-speed ejections at low and medium altitudes. These ejection conditions require a delay before the parachute is deployed, to allow the velocity of the seat to reduce. The stabilizer drogue provides maximum deceleration while maintaining the seat in the optimum attitude for the occupant. The sequence timings of modes 2, 3, and 4 progressively extend the drogue phase with increasing speed and altitude so as to ensure that the parachute extractor is fired only when the seat velocity has reduced to a suitable level. The drogue bridle is jettisoned shortly after the parachute starts to deploy, both to avoid an entanglement and to allow the seat to fall clear of the occupant.

Mode 5 is the high-altitude ejection sequence, in which deployment of the main parachute is delayed until the drogue-stabilized seat falls through the 18,000-feet altitude boundary. This allows the occupant to be brought down to a safer atmospheric condition in the shortest possible time. Once the parachute deployment sequence is initiated, the seat performs in an identical manner to that of modes 2, 3, and 4.

BAROSTATIC RELEASE UNIT (BRU).— When the RH multipurpose initiator cartridge fires during ejection, gas pressure from the cartridge enters the piston housing and moves the piston upwards, rupturing the frangible disc and allowing the pawl to pivot clear of the rack assembly slotted end. When the altitude is such that the barostat is not restraining the mechanism, the rack assembly will rise under the action of its spring, the rate of ascent being governed by the delay mechanism. After the delay has elapsed, the rack disengages from the gear train and the firing pin rises rapidly to strike the cartridge. If the cartridge has not previously been fired electrically by the sequencer, the gas produced by the cartridge passes out of the BRU to operate the upper- and lower-harness locks and the secondary cartridge in the parachute deployment rocket motor.

DROGUE DEPLOYMENT CATAPULT.— During ejection, the drogue deployment catapult fires and ejects the drogue and canister. As the drogue deploys, the bridle breaks out of the frangible container and detaches from the channels on the main beams. The drogue stabilizes and decelerates the seat. In the high-altitude mode, the seat descends rapidly on the drogue to a predetermined altitude. The drogue bridle releases then operate, the personnel parachute deploys, and the occupant separates from the seat. In all other modes, the upper and lower drogue bridle releases operate after a short predetermined delay, as the personnel parachute deploys and seat/man separation occurs.

The impulse cartridge is fired by an electrical signal from the sequencer. Gas from the cartridge propels the telescopic piston upwards, shearing the end cap rivets. Continued movement of the piston thrusts the canister upwards, shearing the rivets in the threaded ring and propelling the canister and drogue assembly away from the seat. The bridle is pulled from its frangible container and out of the channels on the seat's main beams. As the bridle reaches full extension, inertia causes the canister to fly clear, and the drogue is extracted and deployed to stabilize and decelerate the seat.

MULTIPURPOSE INITIATOR.— When ejection is initiated, the catapult ballistic latches operate to retain both multipurpose initiator lanyard spigots. As the seat moves up the guide rails, the static lanyard spigots break the shear pins and the lanyards pay out from the housings. When the lanyards become taut, the upper fittings withdraw the firing pins against spring pressure until the wedge-shaped disconnect devices separate. The firing pins move rapidly upward under spring pressure to fire the cartridges. The gas generated passes to the underside of the piston heads on the start switch plungers. The plungers move up, shearing the shear pins, until the gold-plated portions of the plungers complete an electrical connection in the switch assemblies. Sequencer timing then commences.

Gas from the cartridges also passes out of the units to the barostatic release unit (RH side only), the pitot deployment mechanisms, and the underseat rocket motor.

PITOT ASSEMBLY.— When the pitot assembly is installed on the seat beam, the inboard static pressure connector connects to a void in the seat beam. The sequencer is installed on the forward face of both pitot assemblies and connects to the dynamic and forward static pressure connectors.

On ejection, gas pressure from the impulse cartridges in the multipurpose initiators enters the body and operates the lower piston. Movement of the lower piston pushes the pitot arm locking plunger out of engagement with the hole in the body, and at the same time, opens a gas passage to the upper piston. The upper piston moves outward to move the pitot arm to the deployed position. The pitot arm locking plunger engages with the second hole in the body and locks the pitot arm in the deployed position.

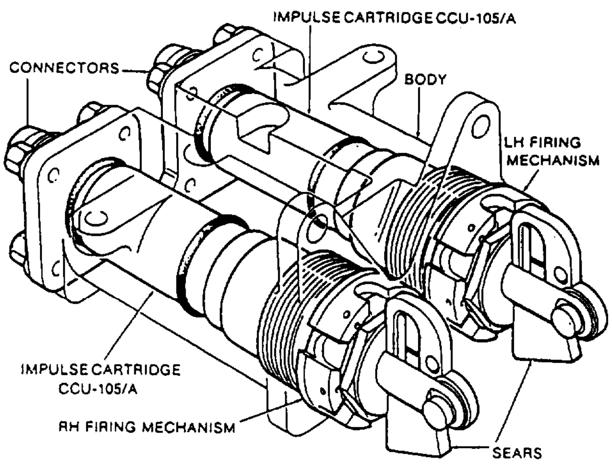


Figure 5-31.-Seat initiator.

RH AND LH BALLISTIC MANIFOLDS.— Pulling the ejection control handle withdraws the handle from its housing and both sears from the seat initiator firing mechanisms to fire both impulse cartridges (fig. 5-31).

Gas pressure from the RH initiator cartridge withdraws the pin puller, freeing the emergency harness restraint release linkage (figs. 5-32 and 5-33). RH gas pressure also passes to the following:

1. The shoulder harness reel to initiate harness retraction.
2. The thermal batteries.
3. The 0.75-second (forward seat) delay cartridge-actuated initiator mounted on the LH ballistic manifold.
4. The 0.30-second (aft seat) delay cartridge-actuated initiator mounted on the RH ballistic manifold.

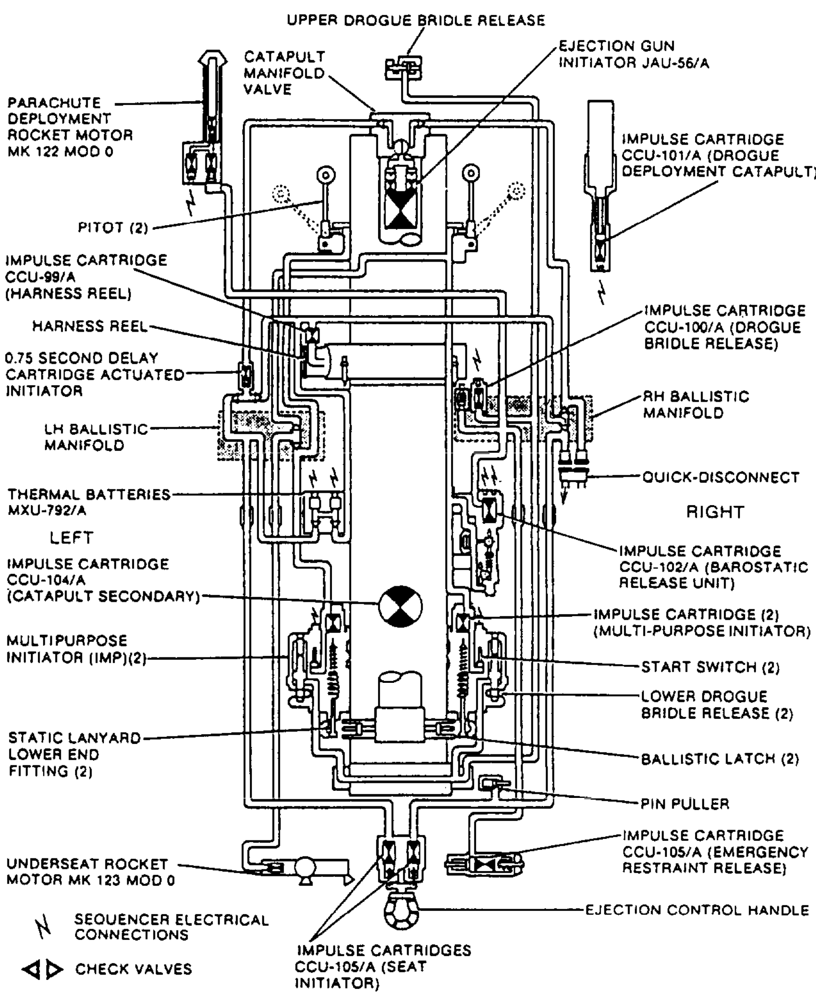


Figure 5-32.-Forward ejection seat gas flow diagram.

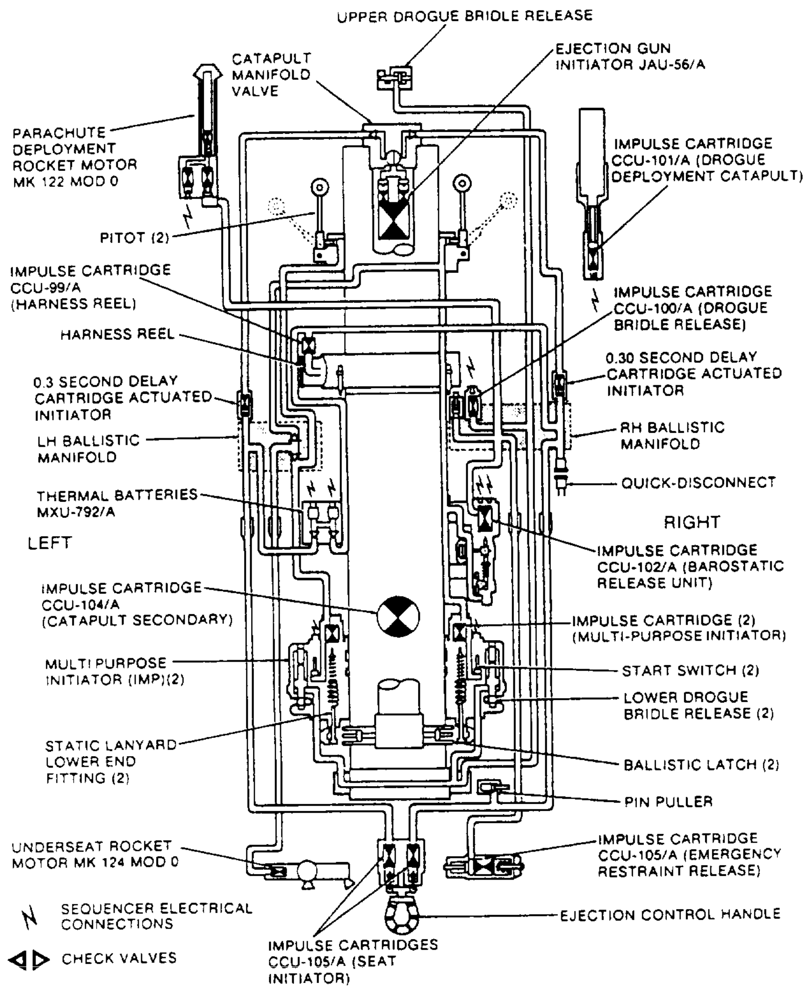


Figure 5-33.-Aft ejection seat gas flow diagram.

Gas pressure from the LH impulse cartridge passes to the following:

1. The thermal batteries.
2. The 0.75-second (forward seat) or 0.30-second (aft seat) delay cartridge-actuated initiator mounted on the LH ballistic manifold, which passes gas to the LH inlet of the catapult manifold valve to initiate the catapult.

THERMAL BATTERIES.— To provide system redundancy, each battery is initiated independently by a manifold-mounted, gas-operated firing mechanism. Both firing mechanisms are initiated by gas pressure from the seat initiator cartridges.

Seat Bucket Assembly

The ejection seat is fitted with a seat bucket assembly. The operation of the components supported by the seat bucket assembly is discussed in the following paragraphs.

UNDERSEAT ROCKET MOTOR/LATERAL THRUST MOTOR.— The underseat rocket motor Mk 123 Mod 0 (forward seat) or Mk 124 Mod 0 (aft seat) is secured under the seat bucket, and is ignited as the catapult nears the end of its stroke. The thrust is approximately 4,800 pounds for 0.25 second, and sustains the thrust of the catapult to carry the seat to a height sufficient for a safe ejection. The thrust also provides the zero-zero capabilities that ensure a safe ejection.

EJECTION SEAT SAFE/ARM HANDLE.— To prevent inadvertent seat ejection, an ejection seat safe/arm handle is installed. To safety the seat, you must rotate the handle up and forward.

To arm the seat, you rotate the handle down and aft. When in the ARMED position, the portion of the handle that is visible to the pilot is colored yellow and black, with the word ARMED showing. In the SAFE position, the visible portion of the handle is colored white, with the word SAFE showing. By placing the handle to the SAFE position, it causes a pin to be inserted into the ejection firing mechanism. This prevents withdrawal of the sears from the dual-seat initiators.

LEG RESTRAINT SNUBBERS.— As the seat travels up the guide rails during ejection, the leg restraint lines, which are fixed to a floor bracket, are drawn through the snubbers. Inertia draws the legs against the front of the seat bucket, and the legs are retained in this position by the leg restraint lines. When the lines become taut and a predetermined load is attained, the special break rings fail and release the lines, leaving only a short loose end protruding from the snubbers. The leg lines are restrained by the snubbers, and the legs secured until the taper plugs are released from their locks when harness release occurs.

EMERGENCY RESTRAINT RELEASE HANDLE.— Rotation of the emergency restraint release handle to permit emergency ground egress will rotate the cross shaft of the lower harness release mechanism to release the lower harness locks, leg restraint line locks, and negative-g strap lock. Full rotation of the handle to withdraw the sear of the firing unit is prevented by the pin puller engaging the rear end of the slot in the emergency restraint release operating link.

SHOULDER HARNESS CONTROL LEVER.– The shoulder harness control lever, mounted on the left side of the seat bucket, is connected to the inertia reel, and provides manual control for the shoulder straps. In the forward position, the shoulder straps will be locked, and in the aft position, the shoulder straps will be unlocked so the occupant will be free to turn and move about.

SEAT HEIGHT ACTUATOR SWITCH.— The seat height actuator switch controls electrical power to raise and lower the seat bucket to suit the needs of the occupant.

PIN PULLER.— During ejection, gas from the RH seat initiator cartridge enters the pin puller plunger housing and lifts the plunger out of engagement with the groove in the piston. Movement of the plunger allows gas to enter the cylinder and withdraw the piston out of engagement with the slot in the emergency restraint release operating link, the piston being held in the operated position by residual gas pressure. The operating link is then disengaged from the lower harness release cross shaft by the action of a spring-loaded plunger in the operating link guide bracket mounted on the seat bucket side.

LOWER HARNESS RELEASE MECHANISM.— When the sequencer fires the barostatic release unit cartridge, the piston in the RH ballistic manifold acts on the harness reel cross-shaft lever. It rotates the cross shaft to withdraw the plungers in the upper harness locks and release the shoulder harness reel straps. At the same time, gas passes via the RH ballistic manifold down the RH trombone tube assembly, entering the emergency restraint release piston housing and face-firing the cartridge. The combined gas pressure from the two cartridges operates the emergency restraint release piston, operating the linkages to release the lower harness locks, the leg restraint line locks, and the negative-g strap lock.

Parachute Canopy and Drogue

During the ejection sequence, the parachute deployment rocket motor fires, extends the withdrawal line, and withdraws the parachute in its bag. The parachute canopy emerges from the bag, periphery first, followed progressively by the remainder of the canopy and the drogue. The extractor rocket and bag clear the area. The drogue and crown bridle impart a force on the canopy, proportional to airspeed, to inhibit full canopy inflation until g-forces are reduced.

Rotation of the emergency restraint release handle to permit emergency ground egress will rotate the cross shaft of the lower harness release mechanism to release the lower harness locks, leg restraint line locks, and negative-g strap lock. Full rotation of the handle to withdraw the sear of the firing unit is prevented by the pin puller engaging the rear end of the slot in the emergency restraint release operating link.

During ejection, gas from the RH seat initiator impulse cartridge enters the pin puller plunger housing and lifts the plunger out of engagement with the groove in the piston. Movement of the plunger allows gas to enter the cylinder and withdraw the piston out of engagement with the slot in the emergency restraint release operating link, the piston being held in the operated position by residual gas pressure. The operating link is then disengaged from the lower harness release cross shaft by the action of a spring-loaded plunger in the operating link guide bracket mounted on the seat bucket side.

Seat Survival Kit

The seat survival kit (SKU-7/A) operates automatically upon seat ejection. Kit components are maintained by the PR rating. The SKU-7/A contains new equipment. Specific information on the new items was not available at the time of development of this manual.

EJECTION SEQUENCE

When the ejection control handle is pulled (fig. 5-34), the sears are withdrawn from the seat initiator firing mechanisms and the two impulse cartridges are fired.

Gas from the RH cartridge is piped as follows:

1. To the pin puller, which withdraws a piston from engagement in the lower operating link of the emergency restraint release mechanism.
2. To the inboard connector of the command sequencing quick-disconnect on the RH ballistic

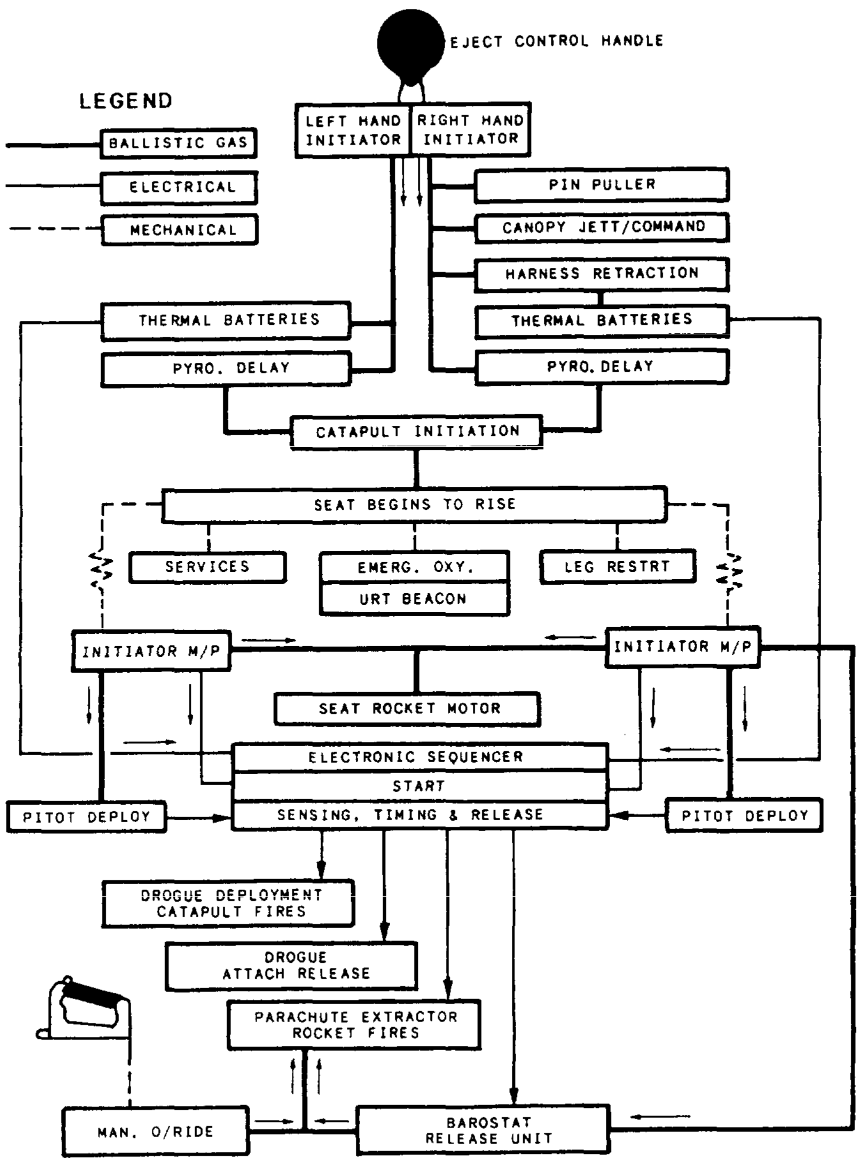


Figure 5-34.-Ejection seat gas flow (block diagram).

manifold to operate the command sequencing and canopy jettison systems.

3. To the 0.30-second delay cartridge-actuated initiator (aft seat only) on the RH ballistic manifold. Gas from the initiator passes to the RH inlet of the catapult manifold valve to initiate the catapult.

4. To the breech of the shoulder harness reel, where it fires the impulse cartridge to pull the seat occupant into the correct position for ejection.

5. To the thermal batteries.

6. Via a check valve to the 0.75-second delay cartridge-actuated initiator on the LH ballistic manifold. Gas from the initiator passes to the LH inlet of the catapult manifold valve to initiate the catapult.

7. If the seat (F/A-18D only) is command ejected (i.e., the ejection control handle on the other seat has been pulled), gas from the command sequencing system enters the RH seat initiating system through the inboard connector of the command sequencing quick-disconnect on the RH ballistic manifold, and operates as described in 1 through 6 above. On the forward seat only, gas pressure also enters the outboard connector of the command sequencing quick-disconnect and is passed to the catapult manifold valve to initiate the catapult. This gas pressure is also piped, via a check valve, to the shoulder harness reel and thermal batteries.

Gas from the LH cartridge is piped as follows:

1. To the thermal batteries.
2. To the 0.75-second delay, cartridge-actuated initiator on the LH ballistic manifold. Gas from the initiator passes to the LH inlet of the catapult manifold valve to initiate the catapult.

Gas from the delay initiator is piped to the ejection gun initiator via the manifold valve. Gas pressure developed by the initiator passes down the catapult to operate the ballistic latches, retaining the IMP lanyard end fittings. As the pressure increases within the catapult, the catapult piston rises, releases the top latch, and begins to move the seat upwards. Further movement of the piston uncovers the catapult secondary impulse cartridge, which is fired by the heat and pressure of the ejection gun initiator gas. Staggered firing of the catapult cartridges provides a relatively even increase in gas pressure during catapult stroke to eliminate excessive g-forces during ejection.

As the seat goes up the guide rails:

1. The IMP lanyards begin to withdraw.
2. Personal services between seat and aircraft are disconnected.
3. The emergency oxygen supply is initiated.
4. The URT-33A beacon is activated.
5. The leg restraint lines are drawn through the snubbers and restrain the occupants legs to the front of the seat bucket. When the leg restraint lines become taut, the special break ring incorporated in each leg line fails, and the lines are freed from the aircraft. Forward movement of the legs is prevented by the lines being restrained by the snubbers.

Near the end of the catapult stroke, the IMP lanyards become taut and operate the firing mechanisms. Gas pressure from the IMP cartridge passes:

1. To the start switch plungers. Closure of the start switches commences sequencer timing.
2. To the barostatic release unit release piston (from the RH IMP only).
3. To the pitot mechanisms to deploy the pitot heads.
4. Via the LH ballistic manifold and trombone tube to the underseat rocket motor. The rocket motor ignites, sustaining the thrust of the catapult to carry the seat clear of the aircraft.

SEQUENCER MODES

Electronic sequencer timing (table 5-2) commences when the start switches close. Mode selection is dependent on altitude and airspeed parameters. (See figure 5-35.)

All modes. The start switches close after approximately 39 inches of seat travel and, after 0.04 second, the drogue deploys onto the bridle to stabilize and decelerate the seat.

Mode 1, low speed - low altitude. The drogue bridle is released, the parachute deployment rocket motor fires to deploy the personnel parachute, and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat bucket by the sticker straps.

Modes 2, 3, and 4, medium and high speeds - low altitude and all speeds - medium altitude. The parachute deployment rocket motor fires to deploy the parachute, the drogue bridle is released, and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat bucket by the sticker straps.

Table 5-2.-Sequencer Timings

Altitude (ft)	0–8K			8K—18K	18K+
KEAS	0—350	350—500	500-600	ALL	ALL
MODE	1	2	3	4	5
1 Gas pressure from seat initiator cartridges, delay cartridge or command sequencing system initiates catapult and thermal batteries	0.00	0.00	0.00	0.00	0.00
2 Start switches close after 39 inches of seat travel	0.18	0.18	0.18	0.18	0.18
3 Sequencer supplies dual pulse to fire drogue deployment catapult	0.22	0.22	0.22	0.22	0.22
4 Sequencer supplies dual pulse to fire drogue bridle release cartridge and release drogue bridle	0.32	—	—	—	4.80 +t (See Note 3)
5 Sequencer supplies dual pulse to fire parachute deployment rocket	0.45	1.10	1.30	2.90	4.87 +t
6 Sequencer supplies dual pulse to fire drogue bridle release cartridge and release drogue bridle	—	1.25	1.45	3.05	
7 Sequencer supplies dual pulse to fire barostatic release unit cartridge and release harness locks	0.65	1.30	1.50	3.10	5.07 +t
8 Sequencer supplies dual pulse to fire barostatic release unit cartridge backup)	0.66	1.31	1.51	3.11	5.08 +t

NOTES TO TABLE 5-2

1. All times are referenced to seat catapult initiation. To obtain times referenced to sequencer start switches, subtract 0.18 sec.

2. Mode selection environmental sensing takes place between 0.245 sec and 0.305 sec (8 microprocessor cycles).

3. In Mode 5 operation, altitude sensing recommences at 4.80 see, continuing until the seat falls to 18000 ft. ´t´ = time interval between 4.80 sec and falling to 18000 ft.

4. Mode decision parameter values are stored in the on-board NOVRAM.

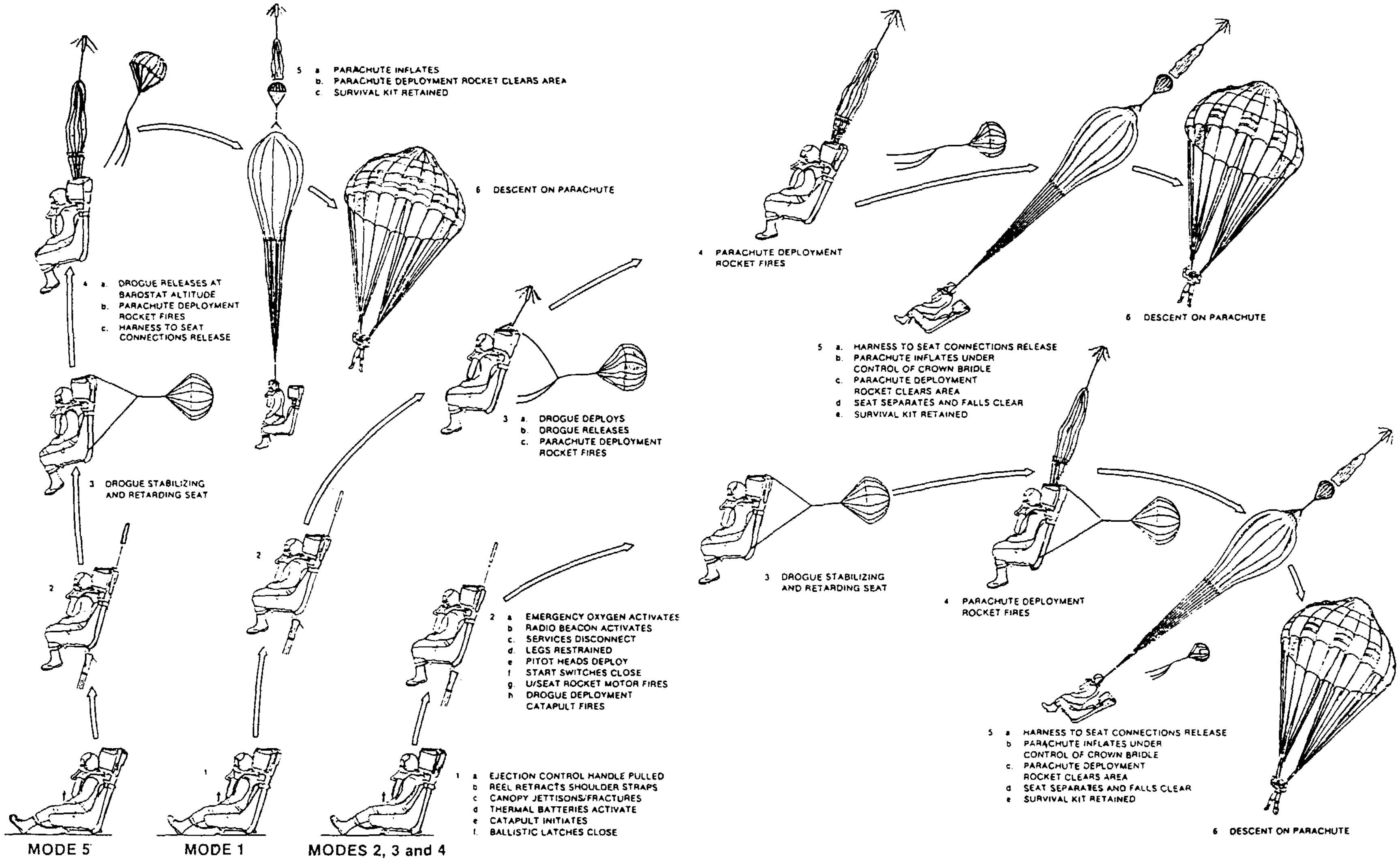


Figure 5-35.—Ejection sequence.

Mode 5, all speeds - high altitude. The drogue bridle remains connected until the seat has descended to 18,000 feet. This arrangement prevents prolonged exposure to low temperature and thin air and enables the occupant to ride down in the seat, controlled by the drogue and supplied with emergency oxygen, to a more tolerable altitude. The seat attitude will be horizontal with the occupant facing down. When the seat has descended to 18,000 feet, the drogue bridle is released, the parachute deployment rocket motor fires to deploy the personnel parachute, and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat bucket by the sticker clips.

All modes. The personnel parachute, when developed, lifts the occupant and survival kit from the seat, pulling the sticker lugs from their clips. This arrangement ensures that there is no possibility of collision between seat and occupant after separation.

ORGANIZATIONAL-LEVEL MAINTENANCE

Learning Objective: *Identify the organizational-level maintenance philosophy for the NACES system.*

The primary task of maintenance technicians is to keep the systems they are responsible for in an operational condition. To achieve this goal, the technician must be proficient in the maintenance, removal, installation, testing, and adjustment of system components. All of this must be performed in accordance with applicable technical publications. Most importantly, all these functions must be done "safely."

Ejection seats and associated components are carefully designated, manufactured, and tested to ensure dependable operation. This equipment must function properly the first time. Malfunction or failure to operate usually results in severe injury or death to crew members. You must always use the utmost care in maintaining escape system equipment. Strict compliance with the maintenance procedures presented in the MIMs and the maintenance requirement cards (MRCs) are mandatory and cannot be overemphasized.

NOTE: The information presented in this chapter must NOT be used in place of information provided in the MIMs.

With the increasing use of diverse and exotic (composite) materials in the manufacture of aircraft components, it is imperative that the proper methods and materials be used to prevent and/or correct corrosion. NAVAIR 13-1-36, *Organizational Maintenance with Illustrated Parts Breakdown Manual*, has been developed to provide specific instructions and repair actions for NACES seat components. It is an in-shop manual written to provide the most complete and technically correct information available to the maintenance technician in one publication. Remember, these manuals are your primary source of maintenance information.

SUMMARY

The Martin-Baker Navy Aircrew Common Ejection Seat (NACES) represents the very latest in escape system technology. It has been designed to provide maximum personnel survivability, a high level of escape comfort, total reliability, and ease of maintainability. For the first time in this field, the power of the microchip has been harnessed to give the seat the unique ability to respond to the variable demands of an ejection situation in a manner far more flexible than was possible with earlier mechanically controlled seats.